The SCIENTIFIC MONTHLY

VOL. LXIV April 1947 NO. 4

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FEB 29 1947

FLAMINGOS

See *The Flamingos of Andros*, page 277

PUBLISHED BY
THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Long-distance Television is twenty years old

At the 1927 demonstration, Dr. Herbert E. Ives explained the television system developed in Bell Telephone Laboratories

APRIL 7 is a notable day in communication history, for on that day in 1927 was the first demonstration of television over long distances. Large-scale images were flashed from Washington, D. C., by wire and from Whippany, N. J., by radio to a demonstration in New York City. "It was," said a newspaper, "as if a photograph had suddenly come to life and begun to smile, talk, nod its head and look this way and that."

That was the first of many public demonstrations, each to mark an advance in the television art. In 1929 came color television, and in 1930 a two-way system between the headquarters buildings of A. T. & T. and Bell Laboratories. When the first coaxial cable was installed in 1937, television signals for 240-line pictures were transmitted between Philadelphia and New York and three years later 441-line signals were transmitted. By May, 1941, successful experiments had been made on an 800-mile circuit.

End of the war brought a heightened tempo of development. Early in 1946 began the regular experimental use of coaxial cable for television between New York and Washington, and a few months later a microwave system for television transmission was demonstrated in California.

Transmission facilities will keep pace as a great art advances to wide public usefulness.

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THE FLAMINGOS OF ANDROS

By PAUL A. ZAHL*

Haskins Laboratories, New York

MOST grotesquely beautiful of birds, flamingos, when approached in their native haunts by an intruder, suddenly sweep into the air like a thousand jets of flame. When seen from a distance, a rising flock may look like a quivering sheet of red fire boiling up out of the surface of a lake. These take-offs are accompanied by rasping, stentorious, gooselike honks coming simultaneously from a thousand angry or frightened throats.

Such a spectacle is not to be found in parks and zoos, where flamingos stalk about with cool superciliousness. Captive birds have had their wings cut and cannot fly; and in confinement they quickly lose the delicate beauty and nervous vitality of wild flamingos. To observe the real thing, one must go deep into the tropics and seek out the flamingos in their native rookeries. Even that may soon be impossible, for the magnificent flocks once found in vast numbers on some of the islands of the Caribbean appear to be dwindling. The shy flamingo has always sought the most isolated locations for his home, and now that airplanes streak through the Caribbean sky, the solitude of the mangrove swamps is no longer secure.

Some authorities fear that the fate which overtook the dodo 300 years ago will eventually overtake the flamingo. For example, the great rookery on Andros Island in the Bahamas which 40 years ago had a population of over 30,000 flamingos, has now been entirely deserted, with only the ghostly remnants of myriads of disintegrating nest mounds remaining as mute evidence of the existence of the former bird-city. The vast flocks are gone, and only sharks and herons inhabit the environs.

Andros Island, lying north of Cuba and off the southeast tip of Florida, is the flat top of an immense submerged coral mountain. Its mesa lifts slightly above the surface of the deep, warm Caribbean, but large portions of it are still a few feet below the surface, giving rise to dangerous shallows. Everywhere underfoot is jagged

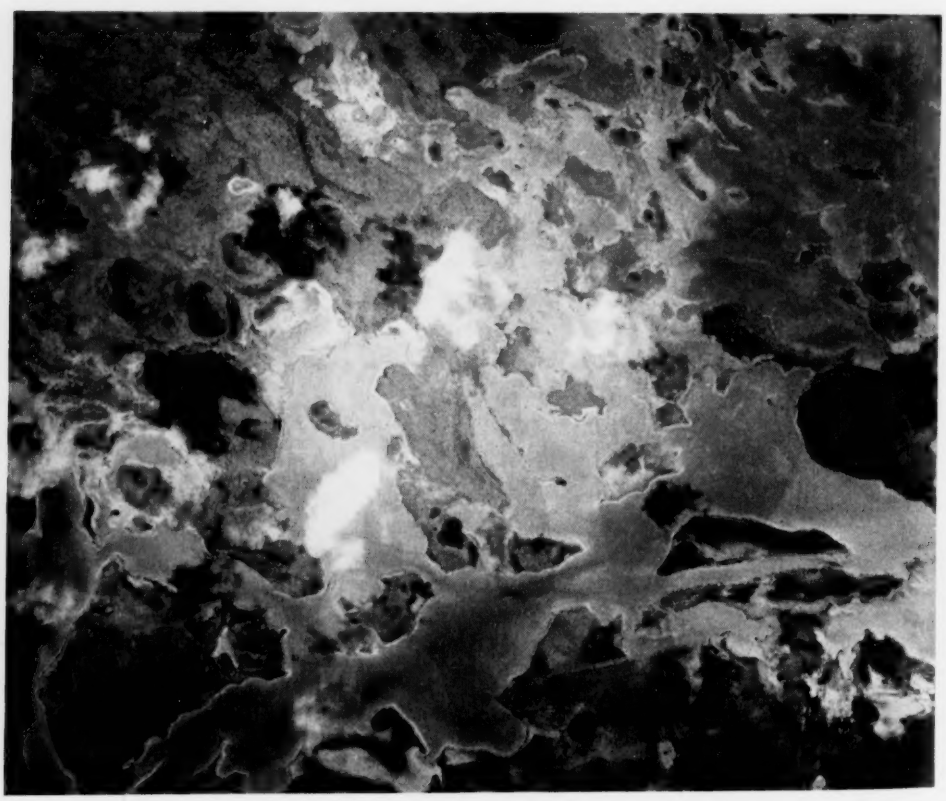
* The author wishes to acknowledge his respect for, and indebtedness to, former Commissioner of Andros E. W. Forsythe, O.B.E., whose pioneering conservation efforts in behalf of the Bahamian flamingo deserve wider recognition and continued support. Grateful thanks, too, are due to various members of the Anglo-Bahamian Petroleum Company, for their many kindnesses during certain phases of the expedition, and to Duane Featherstonhaugh, who accompanied the author on this trip.

and treacherous honeycomb coral rock, and one must wear thick soles or have thick skin on his feet.

A hundred miles long by 50 miles wide, Andros, an old buccaneer refuge, is now inhabited on its east coast by a scattering of black natives, who engage off and on in fishing and in sponge, conch, and coconut collecting. These inhabitants, a jolly, happy lot, live a slow and langorous life, in spite of the fact that the skies and waters off the southeast of Andros constitute the womb of the wild hurricanes which in late summer are apt to rip up the east coast of the United States. Each night the natives, by latching all doors and shutters, close themselves almost hermetically into their white coral-rock huts—but not to keep out the winds or mosquitos. It's the spirits which are kept out by such measures.

That's the east coast. The west coast, the interior, and the southern third of the island are uninhabited and have only recently been explored. Up in Nassau, Andros is known as the Outer Island "where the flamingos are," although not more than a handful of Bahamians, and as few foreigners, have ever gone to the trouble to seek them out.

Flamingos nest in late May and June, just when the rainy season is beginning. Since all birds are most interesting during the nesting season, that's the time we



Courtesy of the Hydrographic Office, U. S. Navy

THE GRASSY CREEK REGION OF SOUTHERN ANDROS ISLAND

THIS AERIAL VIEW SHOWS CAYS AND SHALLOWS IDEAL FOR THE FORAGING AND BREEDING OF FLAMINGOS.

planned for our trip. We also had other biological objectives on Andros, but they are irrelevant.

Between breeding seasons wild flamingos are unapproachable, flying off skittishly when they see anyone approaching them even from great distances. Stories are told how native poachers, spotting a single bird feeding in the middle of a shallow bight, will carefully observe the length of time the bird's head stays under water. In feeding, the flamingo submerges its head for, say, ten seconds, during which time its beak sieves the coral sand of *Ceritheum* mollusks. Then up comes the head, the bird looks about for intruders, and into the water again goes the head for another assault on the mollusks. The bird is disturbed only by moving objects. The native takes advantage of this. Each time the flamingo puts its head under water, the huntsman, carrying a mangrove branch, runs forward. Then, just before he expects the bird's head to come up, he crouches into the water, holding the mangrove branch as a blind. This up-run, down-quiet process is repeated ten or twenty times or until the native is close enough for the final rush. The technique can, of course, be applied only to single birds, for when in groups—which is most of the time and especially during the mating and nesting season—some birds are always on guard while the others are feeding. The slightest movement, even half a mile away, will alarm the sentinel and will send the entire flock skyward and over the horizon.

CERITHEUM MOLLUSKS

OCCURRING BY THE MILLIONS ON THE CORAL SAND BOTTOMS OF THE ANDROS SHALLOWS, THESE ORGANISMS ARE THE EXCLUSIVE DIET OF FLAMINGOS.

We left Nassau by sailboat and landed at Mars Bay, a palm-studded settlement on the east coast of Andros about 30 miles north of the lower extremity of the island. From here in a sailing dinghy, we proceeded down the coast, turning inland at what is known as Grassy Creek. This term is a misnomer, for not only is there no grass, there is also no creek. In fact, the lower part of Andros is not even an island, but consists of thousands of coral masses extending a few feet above the surface of the water and interlaced by shallow salt-water channels which often widen out into huge salt-water lakes. On the coral sand bottoms of these shallows live tens of millions of *Ceritheum* mollusks. These are tapering, spiral-shelled organisms that constitute the sole diet of the flamingos. When we spotted the *Ceritheum* we knew we were getting into flamingo country. Occasionally, as we made our way inland, the fin of a curious shark would cut the water beside us. At first exciting, this sight soon became commonplace.

Since this part of Andros is unmapped, we did not know exactly where the rookery was supposed to be; but from instructions received in Nassau from E. W. Forsythe, former Commissioner of Andros, and from some vague knowledge on the part of our

boatman, we knew the location approximately to within a 5-mile circle. So we set up camp as close to the center of this circle as we could.

Our first sight of flamingos came the very day we were setting up camp. In the late evening sunlight we saw streaking southward a line of 8 huge birds—not pink, as were the flamingos we had seen in zoos, but vermilion, with black wing coverts. These creatures silently and swiftly drew a line of red across the sky. Head and neck straight out in front, long legs heavily aft, and flying with the wing movement and the formation characteristic of the goose family, the octet soon disappeared over the horizon. We learned later that this habit of a flying flock suddenly to disappear in the distance was not due to rapid flight nor to their settling in the water, but rather to a penchant, characteristic of many members of the goose family, for swooping down from an elevation of, say, 200 feet to one of about 2 feet. Flying thus so close to the water that their wing tips actually skim the surface, an illusion of disappearance is created which for a long time puzzled us and led to much useless searching.

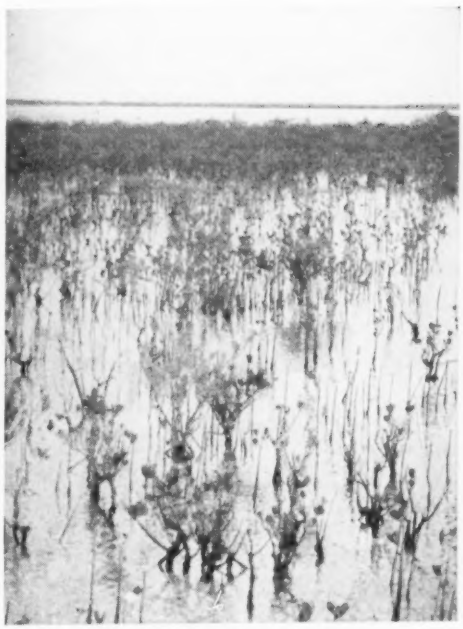
We carefully noted the direction in which the birds had disappeared, assuming, since it was toward evening, that they were rookery bound. We thought, in our naïveté, that by searching in the direction of the birds' disappearance we would quickly find the nesting grounds. So, that night in our hastily built camp, even though miserable (for a torrential rain had started, followed by swarms of mosquitos), we had happy thoughts of next day locating the colony of tens of thousands of flamingos which Chapman had found here in 1905. Forsythe reported that in 1940 the colony was still extensive, with a population of possibly 30,000. But when we had talked to Forsythe a week earlier in Nassau, he had had a disturbed note in his voice. For some years before the war, a warden had been posted near the colony. But we were the first visitors to the area in the five years since the discontinuance of the warden. Forsythe was grateful for our proposed visit, for rumors had come to him by way of the native grapevine that the flocks had gone. He knew, too, that during the war years one of the R. A. F. ferry routes had passed over Andros. He had heard stories of how the weary pilots would sometimes for diversion sweep low when they spotted flamingos and gleefully give chase to the terrified birds. Could these shy creatures take such punishment? Forsythe clearly registered his qualms. We had qualms too, initially; but that night in camp after having seen the 8 flying sheets of flame our confidence was high.

Next morning, by the time the sun was shoving the pink clouds up off the eastern horizon, we were making our way through the mangrove in the direction in which the birds had vanished. The mangrove "swash," as it is onomatopoeically called, is merely shallow salt water in which the mangrove plant is the principal flora. The swash bottom is of coral mud, or marl, much stickier than fresh-water muds and most tiring to negotiate. Beyond the mangrove swash area we came to a large salt-water bight a mile or so across and about 4 feet deep. We alternately waded or rode in a portable rubber boat in the appropriate direction as far as our unfamiliarity with landmarks of the region would wisely permit. We had sent our boatman back to Mars Bay and were now alone and quite at the mercy of this land of coral, mangrove, salt water, mosquitos, crabs, and sharks. Several times during the day we saw flocks of flamingos in the distance, some having as many as several hundred birds. The confusing thing about these flocks was that they appeared from almost any direction and vanished in the

same illogical way. At the end of the third day we concluded that by following the birds we would simply be drawn in all directions and would probably succeed only in getting ourselves lost, without finding the nests of our evanescent quarry.

Then one morning, just as we were preparing to leave camp on another searching jaunt, we were startled by the sound of a single gunshot faraway across the bight to the southeast. As far as we knew, this part of Andros was completely uninhabited. Somewhat alarmed, we set out in the direction of the shot, wading across the bight slowly (constantly, as always, on the lookout for sharks and sting rays) from sand bar to sand bar. At length on a distant bar we spied about 200 flamingo nest mounds. On 3 of them we found eggs, and on a fourth was a broken egg with the red yolk smearing its sides. Our excitement over this discovery soon sobered when we discovered fresh prints of a naked human foot in the sand and dozens of red and black feathers. Clearly someone that very morning had shot one or more flamingos and carried them away. This must be the work of a native poacher.

All natives on Andros know that severe penalties await anyone caught stealing flamingo eggs or killing the birds. But flamingos, both young and adult, as well as the eggs, are delicacies to cheer the heart of any gourmand. Reputed to be even more savory than chicken, the flamingos on Andros for this reason have several times faced extinction because of wholesale slaughter by the natives. The story is told that some years ago the only native who then knew the location of the flock came to the rookery during the laying season and filled his boat with thousands of fresh eggs, which he sold at a handsone price to coastal inhabitants. That year there were few new flamingos. It is also said that late in the summer when the nestlings were large but just in their preflight stage, two men, each holding the ends of a long thong, would rush groups of wading young and break the birds' legs with sudden jerks of the cord, thus making capture easy.



ANDROS MANGROVE SWASH

A STICKY BOTTOM LIES UNDER THE SALT WATER.

So a law was passed in Nassau, and, with assistance from the Audubon Society, a warden was appointed. That stopped mass slaughter but apparently not occasional poachers such as the one whose gunshot we had heard. We found no further evidence of him, however; perhaps he spotted our camp and made a hasty departure from the area. We were grateful to him, for his shot led us to our first nests. But, alas, except for the 4 eggs there was no sign of birds; the adults never returned. A few days of exploration disclosed thousands of other old, disintegrating nest mounds on adjacent islands and sand bars. Mangrove roots were growing over and through the nests. Clearly, the Chapman flamingo city had gone the way of Mayan cultures.

But what about the birds that each day crisscrossed the sky? They must have a home. We extended our searching farther and farther from the base camp. There were plenty of herons, gulls, and osprey, but only a few flamingos wading in the distance. Each night when we returned to camp we hoped that the next day would bring discovery. But days and weeks passed, and no rookery.

There was no fresh water on our camp island or, for that matter, on any of the other cays. We depended solely on the brown wriggler-filled rain water found in the dirty coral holes or on the rain water collected by our tent tarpaulin. Big orange crabs overran the island and supplied our principal camp diversion. Everywhere darting in and out of coral crevasses, these creatures were our constant companions. At night as we sat in our tent, dozens of them idled about like dogs begging for a morsel. Occasionally we fed them, but they also fed us; for we soon enough found out how tasty they became when dropped into boiling water. And the supply was limitless. No matter how many we ate, the total number of grotesque tent guests never seemed to diminish.

At length this became tiresome, and, after we had achieved our other fiological aims, we broke camp and made our way out to the coast, rather crestfallen, for, although we had seen many flamingos on the wing, we had failed to find evidence that they were breeding.

Then one morning at the mouth of Grassy Creek we bumped into Robbie Ferguson, a native Negro, who announced that he and he alone knew where the flamingos were nesting—thousands of them. We listened skeptically but, after hearing his prayer that God might strike him dead if he were lying and because of his insistence that he would accept no payment if he didn't take us directly to at least a thousand active flamingo nests, we gave ourselves into his care and boarded his sailboat, which smelled of shark liver and putrefying turtle meat.

Robbie, we found, knew what he was talking about, because during the war years he had been watching the flamingos deserting the Chapman rookery and dwin-

A FLAMINGO GHOST TOWN

THIS IS A CORNER OF THE VAST ROOKERY THAT WAS DESERTED BY THE FLAMINGOS DURING THE LAST WAR.

AMIDST EGGS AND NESTS IN THE FLAMINGO ROOKERY

BEFORE THE BAHAMIAN FLAMINGO LAWS WERE PASSED, NATIVES WHO KNEW THE LOCATION OF THE ROOKERY WOULD USE IT AS THEIR SECRET SOURCE OF FRESH EGGS. THE ABOVE HATFUL WAS FLOATING IN WATER.

dling in numbers. The remnant, he said had moved to the farthest southern tip of Andros, the most deserted and desolate spot the birds could find for setting up a final bastion against an encroaching world. And it was here one afternoon, after sailing down into what seemed almost the edge of the world, that we came upon our real flamingo rookery.

It was midafternoon, and the sailboat had become becalmed, so we set out in the dinghy and poled our way a mile or two into shore; then another mile through mangrove swash, and again into another salt lake whose surface was as smooth as glass. Suddenly from far across the lake came the faint conglomerate sound of a thousand distant squawks. We pressed on, now wading hip-deep; finally we began to make out on the remote shore a streak of pink color, which as we came closer could be discerned as a vast assemblage of flamingos. Through the binoculars they could be seen more clearly. Some were sparring with one another, with black-tipped wings flapping in graceful cadence. Some were straining their necks and looking in all directions. Small contingents of 20 or 30 birds with great fanfare were intermittently arriving at the rookery, presumably from distant feeding grounds. Other groups were taking off and circling the area.

The birds first spotted our approach across the bight when we were perhaps a thousand yards away. We knew this, for all at once the chatter of the flock turned into an apprehensive silence, and heads periscoped in our direction. The standing birds began to pace nervously, and many of the females arose from their nests and joined the males in their disturbed alarm. The clamor and chatter began again and became louder and louder as we got closer. The confusion became bedlam. I think we must have been no more than 100 yards away when, with the roar of a battery of Gatling guns, the thousand huge flamingos boiled into the sky.

From a tepid pink, the color suddenly changed to a bright red, for all wings, revealing carmine flanks and black covert feathers, were now beating furiously in the

tumultuous take-off. The sight was one of the most breathtaking I have ever witnessed in the world of nature.

Not quite all the birds took off. A few hardy females stayed faithfully on their nests or stalked anxiously close by. The main flock wheeled overhead, still creating an unearthly clatter; and, as we had frozen in our tracks, in a few minutes groups of 50 or 100 began returning. The sight of flamingos settling is almost as spectacular as that of the take-off, especially when an individual bird is watched. As he glides down the runway, his spread wings tilt gently back and forth as though testing, and the sight is somewhat reminiscent of a Piper Cub coming in. The landing gear is slowly lowered, legs extending down and slightly forward. As the toes touch the water, the bird goes into a rapid run, decreasing in speed until the momentum of flight is overcome. The take-off is practically this in reverse. The bird starts running at ever-increasing speed, leaning forward and virtually running on the surface of the water until wing motion finally takes over. It is all as delicate and rhythmic as a ballet. Robbie Ferguson says that even more interesting are the fledglings toward the end of the summer when they are first learning to fly. Apparently they do not have much trouble learning the take-off, but the landing technique comes slowly. During a critical period of several weeks he says that the young always crack up when landing, for they do not know how to use their legs for deceleration when striking the water. As a consequence, their otherwise graceful landing is attended by a series of awkward flip-flops.

Apparently males and females alternate in sitting on the eggs. The adults while brooding fold their long legs under the body very much as other sitting birds do. The young are born after a 28-day incubation period; they are white, fluffy, chicklike creatures with straight beaks. For many months they are dependent on regurgitated parental food because their slow wing development prevents flight to distant feeding grounds. Furthermore, their beaks and necks do not become specialized for *Ceritheum* foraging until relatively late in life. It is the peculiar beak and neck adaptation on which the adult birds depend for survival. They arch their submerged heads so that the head is actually inverted

A FLOCK OF UNDISTURBED FLAMINGOS

AS THE OBSERVERS APPROACHED ACROSS THE BIGHT AND CAME WITHIN A THOUSAND YARDS OF THIS FLOCK, THEIR CHATTER SUDDENLY TURNED INTO AN APPREHENSIVE SILENCE AND THEIR HEADS PERISCOPED.

FLAMINGOS ABOUT TO FLY

IN THE TAKE-OFF THE BIRDS RUN AT EVER-INCREASING SPEED UNTIL WING ACTION FINALLY TAKES OVER.

and the beak pointed backwards. Then with a swinging motion they sift the coral sand for *Ceritheum*. While doing this they slowly move forward in the water. The number of *Ceritheum* needed to maintain a large flock of flamingos must be astronomical. Since *Ceritheum* constitutes the sole diet of the wild birds, it is clear why the young have to remain dependent on parental feeding until their straight beaks have developed into the clumsy feeding organs which give the adults their grotesque appearance.

The colony was now thoroughly disturbed, birds coming and leaving at about the same rate. We could see from the distance that each nest mound had one chalky-white egg on it. We were perplexed, however, by the sudden realization that floating on the surface of the water through which we were wading were literally hundreds of eggs. We began to notice, too, that entirely submerged on the floor of the lake—about 2 feet deep at this point—were hundreds of completely inundated nest mounds. It was obvious that at the beginning of the season the birds had started building their mounds along the shore, not knowing that the late spring tides would bring the water level up about a foot. All the earlier nests had had to be abandoned, and of course the eggs were carried off by the rising water.

Another tragic observation, which, by the way, does not mark the flamingo with too high an intelligence, is that every time the flock takes off, dozens of eggs are knocked from the mounds and are broken. Yolk and embryo remains are found everywhere. For this reason we revisited the rookery as few times as possible, for each time that we caused a general alarm we knew we were contributing to the extinction of many potential birds. Also, whenever the flock was away from the rookery (which was only when the birds were disturbed), vultures

WILD FLAMINGOS IN FLIGHT

UNLIKE THOSE SEEN IN ZOOS, THEIR COLOR IS VERMILION WITH BLACK WING COVERTS. THEY FLY WITH HEAD AND NECK STRAIGHT OUT IN FRONT, WITH THEIR LONG THIN LEGS STRETCHED OUT TO THE REAR.

appeared from nowhere, ready to swoop down on the eggs or young. Lizards, too, quickly put in their appearance as egg robbers.

As we moved away from the rookery that day, the birds, some of which had been circling and others of which had landed on an adjacent lake, began coming back. By the time we were 1,000 feet away, splashing through the bight hurriedly (for the sun had gone down and our boat was still miles away), the majority of the birds had returned to the rookery. I looked back from a distance of perhaps half a mile and saw the same streak of orange-pink on the far shore as had been there when we approached.

FLAMINGOS belong to the family Phoenicopteridae, which consists of only 3 genera and 6 species. *Phoenicopterus ruber*, the roseate flamingo, is found on a number of the West Indies islands, although the islands of Inagua, Abaco, and Andros have been considered to be the principal breeding places of the Carribbean birds. If the situation observed on Andros may in any way be considered typical, then serious thought should be given to the possibility of the birds' eventually becoming extinct. The depressing history of the roseate spoonbill in Florida is evidence that conservation measures should be taken long in advance of the actual extinction threat.

There is little doubt that the deserted rookery which we found on the old Chapman site has an unhappy significance, especially since the new rookery on the southern Andros cay is numerically nowhere near the size of the former Chapman colony. From the conservationist point of view, it is of interest to inquire into the

reason for this migration and shrinkage. It does not seem likely that food supply is a factor. Andros flamingos feed entirely on the *Ceritheum* found in the bights and salt-water shallows so abundant all over the southern part of the island. These vast feeding areas are just as readily available from the Chapman location as from the new rookery. Too, in the immediate vicinity of the old rookery we found a plethora of *Ceritheum*. One doubts, furthermore, whether the specialized *Ceritheum* diet is as important to flamingo euthenics and survival as was formerly supposed. The flock of defledged flamingos maintained at Hialeah Park, Miami, has for a number of years been fed on synthetic diets entirely lacking in *Ceritheum*. These captive birds, although not as gorgeous in coloration as the wild flamingos, nest, mate, and brood very successfully.

As to the possibility of epidemiological factors in the disappearance of the Chapman colony, little can be said other than that during our visit, at least, there was no sign of sick or dead birds.

One doubts that the activities of native poachers have contributed in any major degree to the disappearance of the birds. Poaching has been going on ever since the settling of Andros Island. Large-scale or organized poaching was effectively stopped by the Bahamian flamingo laws. Such predators as the one whose gunshot we heard are probably of little consequence. Evidence for this is the fact that the birds survived in full number until as late as 1940 despite isolated cases of individual native molestation.

FLAMINGO NESTLING

SUBMERGED FLAMINGO NEST
AN EGG FLOATS NEAR THE INUNDATED NEST.

The influences which brought about the desertion of the Chapman colony are probably of a more general nature. And one is rather inclined to the conclusion that the flamingo migration and diminution are more properly ascribable to the hysterical flight caused among the birds by airplanes.

The dissolution of the Chapman rookery appears to be synchronous with the outbreak of war in 1940. The immense air bases and training centers on New Providence Island, only about 100 miles from the Chapman rookery, certainly introduced a widespread disturbance in the Bahamian skys. As stated before, it is quite common knowledge that many a young, mischievous pilot reduced the weariness of his flying

hours by giving chase to the conspicuous red birds in the vicinity of Andros. The consequence of such nerve strain on the already nervous personality of the flamingo is not difficult to imagine. Also, during the war the American military forces made an aerial map survey of Andros, including the Chapman rookery area. This day-in, day-out air activity could hardly have added to the flamingos' sense of security.

In the past year or two the whole of the island of Andros has been subject to elaborate oil-prospecting activities. Although the surveyors and engineers with whom we made contact during our trip were most careful not to cause alarm to any flamingos they happened to encounter and though they had not as yet reached the southern extremity of the island where the flamingos are reconstituting themselves, it is undeniable that their motorboats plying up and down through bights and channels rarely before visited and the concomitant air activity constitute a nerve-racking intrusion so far as the flamingo is concerned.

One can also venture the guess that the birds of the Chapman colony, early in the war years, found the airplane disturbance intolerable and at length fled to the most remote extremity of the island to set up their new rookery. If each time an airplane comes over, the usual egg damage occurs from the sudden flight of the birds, the reproduction rate of the flamingo is certain to decrease, perhaps dangerously near to the extinction point. In the new rookery we found only a few thousand birds. There were 30,000 in the Chapman rookery in 1940. Where are the missing thousands? Possibly there are other new rookeries elsewhere on Andros, to which the birds fled, although we know of none. Possibly many of the birds migrated to such less disturbed islands as Inagua or Abaco. In any case, during the war years, what appeared to be a stabilized rookery became deserted, and the noble efforts of the Audubon warden and such conservationists as former Commissioner Forsythe to preserve this colony have been virtually undone. The Chapman flamingo city was as surely a war casualty as was Amsterdam or Leningrad. Whether the birds in their new rookery will recover and develop into the vast colonies of former days cannot be predicted. If oil is discovered on Andros and if large-scale drilling and pumping occurs, one cannot but envisage a dreary prognosis for the flamingo.

One can only hope that in the normal advance of man and his technology, the flamingo will not be subjected to continued or excessive disturbance. Setting aside a preserve for the bird is probably impracticable because of the vast areas of salt shallows required to feed large flocks. This is especially difficult if such areas are of commercial value. Andros Island until recently was a desolate and forgotten land. That was why the flamingo prospered. If commercial exploitation sets in for oil or any other resource, the fate of the bird, at least on Andros, is sealed. The beautiful creatures already have too many cards stacked against them to make frequent human intrusion anything but disastrous. Biologically the flamingo is so highly specialized an organism that adaptation to disturbance or to new or changing conditions is difficult or impossible.

MICROBIOLOGY IN THE U.S.S.R. IN 1946*

By SELMAN A. WAKSMAN

Agricultural Experiment Station, New Brunswick, N. J.

IT HAS been said that the "germs know no national boundaries." One might paraphrase this truth thus: The search for germs and their role in human health and in human disease knows no national affiliations. This was brought home to me very forcefully during the summer of 1946 when I had an opportunity to look into the progress made in the Soviet Union during the war years in the field of microbiology.

A knowledge of the language and an acquaintance, either personal or by correspondence, with many of the Russian microbiologists made it possible for me to cover much ground in a short time. My survey of the development of microbiology in the Soviet Union was more intensive than extensive since my visit was limited mainly to Moscow, with a shorter visit to the second largest city, Leningrad. In these two cities the scientific organizations of the country are largely centered. Here I had ample opportunities to meet a number of scientists from other centers and thus gain an insight into the development of microbiology in the country as a whole.

BACKGROUND

Following the epoch-making investigations of Pasteur, microbiology progressed in Russia along two lines very similar to those in the U. S. A. and in other countries: general and agricultural microbiology and medical bacteriology. The outstanding representatives of these two fields of microbiology in Russia were S. N. Winogradsky and I. I. Metchnikov, respectively.

The background for the development of general and agricultural microbiology in Russia is to be found in the work of the great Russian botanists, plant pathologists, and plant physiologists. It is sufficient to mention four names: L. C. Cienkovski, who was a botanist by training and later became famous for his work in protistology, chiefly in bacteriology and protozoology; two of Cienkovski's most brilliant students, M. Woronin and A. S. Famintzin, both of whom became famous for their work on root-nodule bacteria and on slime-producing bacteria, respectively; and D. I. Ivanovski, who first observed and described the infectious nature of the filtered juice of leaves with tobacco mosaic disease, namely, plant viruses.

Winogradsky, the greatest Russian microbiologist and soil bacteriologist, was a student of Famintzin. It was Winogradsky who in 1891 organized, at the Institute of Experimental Medicine, the first microbiological laboratory in Russia. Upon his retirement in 1905, his place was taken by his assistant, V. L. Omelianski. Upon the death of Omelianski in 1928, he was succeeded by V. L. Issatchenko, who later became the chief of the Microbiological Division of the Academy of Sciences, which was established in 1930.

The development of medical microbiology in Russia is closely associated with the name of Metchnikov, zoologist, pathologist, and bacteriologist; N. F. Gamaleia, who became famous for his work on plague, cholera, tuberculosis, and virus infections; D. K. Zabolotni and G. D. Belonovski, both of whom have made important contributions to our knowledge of the epidemiology of typhus, of cholera, and of other infectious diseases.

* Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Microbiology, Rutgers University.

The Academy of Sciences and the All Union Institute of Experimental Medicine (VIEM) are the two outstanding organizations that devote considerable attention to the subject of microbiology, from a broad general and agricultural point of view, on the one hand, and from an applied medical point of view on the other. In addition to these two important organizations, the corresponding academies in the various constituent republics, notably in the Ukraine (Kiev, Kharkov), devote a great deal of attention to this subject.

Mention must also be made of the various ministries, such as those of public health, manufacture of medicinal preparations, food industries, and fermentation industries; the universities, agricultural colleges, and other teaching and research institutes; and, finally, the agricultural experiment stations.

Some of these organizations have special institutes devoted to the manufacture of microbiological products. For example, the Institute of Epidemiology and Bacteriology in Moscow is concerned with the manufacture of toxins, antitoxins, serums, vaccines, antibiotics, and other bacteriological products, and the Institute of Microbiology in the name of Zabolotni in Kiev is concerned with the manufacture of various medicinal and agricultural bacteriological products.

Certain problems in the field of microbiology, both fundamental and applied, overlap into several of the above organizations. The subject of antibiotics, for example, is one such problem. At least five of the ministries and the Academy of Sciences are vitally interested in the search for new antibiotics, in the manufacture of those that have already established their practical value, such as penicillin, and in the application of these antibiotics to disease control.

A detailed analysis of some of the work in the field of microbiology in the U.S.S.R. at the present time can perhaps best be presented in this brief survey by describing some of the activities of the Academy of Sciences and by drawing attention to the development of the subject of antibiotics.

ORGANIZATION OF THE INSTITUTE OF MICROBIOLOGY OF THE ACADEMY OF SCIENCES OF THE U.S.S.R.

Director of Institute: V. L. Issatchenko.
Assistant Director: M. F. Kriss.
Scientific Secretary: A. E. Kriss.

1. *Division of General Microbiology:* C. I. Kuznetzov.
2. *Division of Ecology of Microorganisms:* A. A. Imshenetzki (*Vice-Director*).
3. *Division of Bioceonology of Microorganisms:* N. I. Krassilnikov.
4. *Division of Soil Microbiology:* E. N. Mishustin.
5. *Division of Systematics and Philogeny of Microorganisms:* V. N. Shaposhnikov.
6. *Division of Viruses:* V. L. Rishkov.

Total number of senior scientists	12
Total number of junior scientists	13
Number of laboratory assistants	23
Office personnel	5
Total staff	62

ACTIVITIES OF THE INSTITUTE OF MICROBIOLOGY

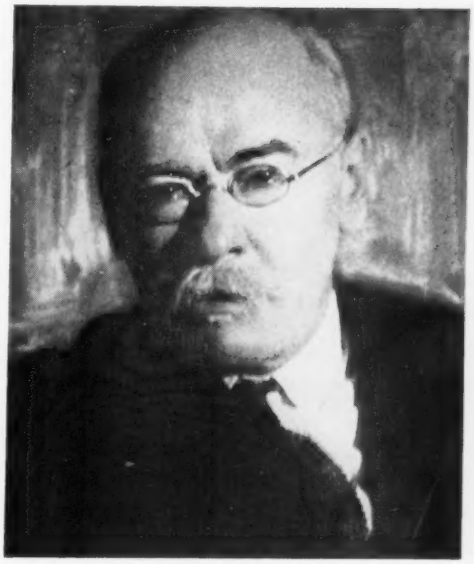
As the plan of organization indicates, the activities of the institute cover the various aspects of general and agricultural microbiology. This includes the ecology of microorganisms, their physiology, chemical activities, and their role in soil processes and in water basins and as causative agents of plant diseases.

Of the problems of a general microbiological nature, only a few need to be listed here. M. N. Meissel and assistants are studying the function of growth-promoting substances in the growth of microorganisms, especially the action of thiamine upon yeast. The function of thiamine as a biological regulator of cell structure is differentiated from its role in the activities of the cell. The synthesis and accumulation of thiamine were found to be influenced by the particular conditions under which yeast fermentation takes place. Methods

for the quantitative determination of thiamine and thiazole are based upon the use of the fungus *Endomyces magnusii*. A study has also been made of the phenomena of hypervitaminosis and avitaminosis among microorganisms, resulting from an unbalanced relation of thiamine and biotin. This led to an investigation of the volatilization of vitamins, a phenomenon characteristic of the thiazole fraction of thiamine. Microorganisms were found to be capable of absorbing from the air this thiamine fraction and of synthesizing the complete vitamin molecule. By utilizing microorganisms as test agents, it was possible to demonstrate that certain growing plants, such as peas, give rise to volatile thiamine or thiazole. This was also found to be the case for nicotinic acid and for p-amino benzoic acid.

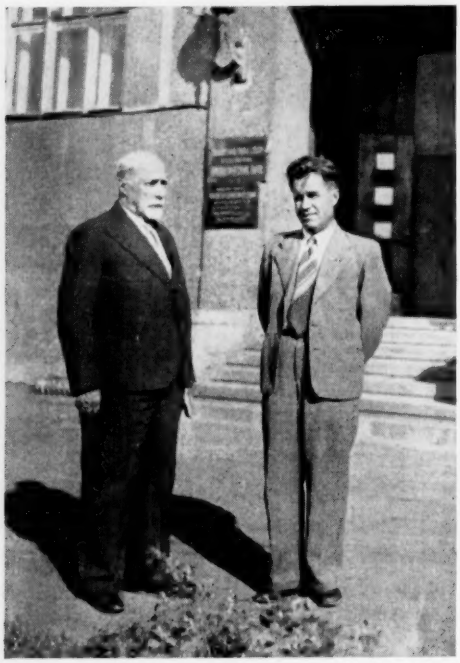
The effect of ergosterol on yeast fermentation is being studied by T. A. Tausson. The formation of carotenoids and their role in the physiology of red yeasts are being studied by Miedviedieva. A study of the effect of carcenogenic substances on the microbial cell brought out the fact that considerable accumulation of such substances may take place; these may be retained in the cells for a long time. The localization of carcinogenic agents in the microbial cell results in a sharp irritation of the cell followed by formation of mutants.

S. N. WINOGRADSKY
SHOWING THIS FAMOUS RUSSIAN MICROBIOLOGIST ON HIS NINETIETH BIRTHDAY, SEPT. 14, 1946, AT BRIE-COMTE-ROBERT, FRANCE.



V. L. OMELIANSKI
PICTURE TAKEN FEBRUARY 25, 1925.

Considerable attention is given to the problems of structure, life cycle, and systematics of microorganisms. Kudriavtzev is working primarily with yeasts, Krassilnikov with actinomycetes, and Imshenetzki with bacteria. In a series of papers published in *Microbiologia* for 1942-46, Kudriavtzev demonstrated that the classification of yeasts, based upon the recognition of types that have become fixed as a result of continued cultivation under artificial conditions, may result in a totally different perspective from a comparable study of yeasts in their natural environment. Such phenomena as the size and shape of the cell, the formation of giant colonies, and the relation of the organism to gelatin and to the nitrogen source should not be considered as factors which determine the development of organisms in their



TWO MICROBIOLOGISTS

V. L. ISSATCHENKO (*left*), DIRECTOR OF THE MICROBIOLOGICAL INSTITUTE OF THE ACADEMY OF SCIENCES; N. I. KRASSILNIKOV (*right*) CHIEF OF ONE OF THE DIVISIONS OF THE INSTITUTE.

struggle for existence and, therefore, not for species characterization. Because of this, the number of yeast species now recognized must be markedly reduced. For example, *Saccharomyces cerevisiae* and *S. ellipsoideum* were recently combined into the single species *S. cerevisiae*. The fact, however, that *S. cerevisiae* occurs largely under the artificial conditions of beermaking and wine making, where it develops a high fermentation rate, whereas *S. ellipsoideum* persists only in such substrates as fermenting fruit juices, suggests the existence of two independent types.

Imshenetzki has made a detailed study of the structure of bacteria and of bacterial dissociation. He does not recognize the existence of any correlation between colony shape and other characteristic properties of the bacterial cells. The ash content of the R and S variants of *Sarcina flava* was found to be identical; both variants were equally resistant to high temperatures and both were alike in the intensity of their respiration. Rough variants were frequently found to be more active than smooth ones, which is contrary to the dissociation theory.

Krassilnikov and A. E. Kriss have concentrated their attention upon the study of the Actinomycetales, their morphology, their systematic position, their physiology, and especially their antagonistic properties. Several monographs have been published, most important of which are the two by Krassilnikov on the Actinomycetales and related organisms and a key to the Actinomycetales.

Krassilnikov and his group have also been concerned with the relation of microorganisms to the root systems of plants. The state of the roots of plants and their secretions greatly modify the nature and abundance of the bacterial population of the rhizosphere. Under certain conditions of plant cultivation, this results in an accumulation of phytopathogenic bacteria and fungi. The role of microbial antagonists in combating these plant-pathogenic organisms has been investigated. The function of "mycolytic bacteria," first elucidated by Chudiakov in 1935, was given special consideration. These bacteria, largely of the *Pseudomonas* and *Achromobacter* types, have a marked lytic action upon *Fusarium* and other phytopathogenic fungi. It is sufficient to mention the bacteria which dissolve the fungus *Verticillium dahliae*, the causative agent of cotton wilt, and the bacteria which dissolve *Fusarium*, which causes fusariosis of pines, flax, and cotton. Favorable results are said to have been obtained from the use of such bacteria for the purpose of combating plant diseases, not only under controlled laboratory conditions but also in the field. The seeds of the plants are treated with

cultures of the bacteria (bacterization), resulting in a reduction in plant destruction caused by fungi and in an increase in crop yields. The treatment of soil with cultures of the fungus *Trichoderma lignorum* grown on sugar-beet pulp is said to give a marked increase in crop yield, owing to improvement in soil structure and to the formation of phytohormones which favor plant development.

The problem of nitrogen fixation, both by root-nodule bacteria and by free-living bacteria of the Azotobacter type, continues to receive marked attention in the Soviet Union. In addition to the universally accepted principles of legume inoculation (Nitragin preparation) and of the importance of legumes in crop rotations, problems not so universally recognized continue to receive attention; for example, the claim that leguminous plants are able to fix nitrogen under sterile conditions not only in the presence of root-nodule bacteria but also in the presence of certain other bacteria. One must classify into the same category the claim that inoculation of soil with cultures results in a greater nitrogen potential in the soil. These assumptions led to the development of "bacterial fertilizers," or "soil improvers." One of these preparations, designated as "Azotogen" and consisting largely of an *Azotobacter* preparation, is being utilized on a large scale throughout the Soviet Union. It may be emphasized here, in passing, that whereas there is no question of the great value of the inoculation of leguminous plants with specific root-nodule bacteria, the use of *Azotobacter*, as well as of the so-called ammonifying and phosphate-mobilizing bacteria, and even of plant-disease-combating organisms for soil inoculation under field conditions, has not found favorable application in this country, and the value still remains to be established.

Geographical distribution of specific bacteria, such as *Bacillus mycoides*, and their role in soil-forming processes is the subject of special investigations by Mishustin and his group. Southern strains of *B. mycoides* were found to have a higher temperature optimum and a greater potential for multiplication than comparable strains found in areas under colder climatic conditions. The distribution of spore-forming bacteria in the soil was found to be closely correlated with the transformation of organic matter. Other bacteria as well were found to serve as good indicators; thus, the presence of the *E. coli-A. aerogenes* group determines the degree of soil pollution. A higher moisture content favors bacterial development, whereas lower moisture favors fungi and actinomycetes.

D. I. IVANOVSKI
AN EARLY INVESTIGATOR OF PLANT VIRUSES.

The study of viruses, begun so auspiciously in 1892 by Ivanovski, has been continued in the Soviet Union by a host of investigators. It is sufficient to mention the work of Rishkov and his associates in the field of plant viruses and of A. A. Smorodintsev and L. A. Silber on animal viruses. Rishkov, now in charge of the

C. A. ORBELI

SECRETARY OF THE ACADEMY OF SCIENCES FOR THE BIOLOGICAL SCIENCES. HE IS ALSO THE DIRECTOR OF THE PAVILOV INSTITUTE.

virus division of the Microbiological Institute of the Academy, is the author of a book on virus diseases of plants and of a series of papers on the isolation and nature of plant viruses. Smorodintsev's work on influenza virus and antiserum has attracted universal attention and has found wide application in this country as well. Silber is connected with the Institute of Epidemiology and Bacteriology; he has recently written a treatise on virus diseases of animals.

Numerous other investigations in the field of general and agricultural microbiology are being carried out in the Soviet Union, either in the various academies or in some of the other research and teaching institutions. These deal with problems pertaining to agriculture and industry. Examples include the work of Novogrudsky on the microbiological processes in semi-desert soils, of Panosian on ammonia formation in Armenian soils, and of Krassilnikov and associates on the microbiological problems of "soil fatigue." The industrial problems comprise the work of Shaposhnikov on citric and lactic acid fermentations, of Brockaia on thermophilic proteolytic bacteria, of Imsenetzki on thermophilic cellulose-decomposing bacteria, and of Tausson and Seliber on fat synthesis and fat decomposition by bacteria and actinomycetes; the work on the bacteriology of hydrocarbons, notably their decomposition and the role of this process in the origin of petroleum; the occurrence of bacteriophage in sewage purification and its function as an indication of fecal contamination; and much other work.

ANTIBIOTICS

I found considerable interest in the subject of antibiotics in the Soviet Union. At least five of the ministries, the Academy of Medicine, and the Academy of Sciences are devoting time to this subject. Although I spent most of my time in Moscow and only a few days in Leningrad, I had ample opportunity to visit the most important laboratories devoted to this subject, as well as to speak to various scientific workers from other parts of the country.

The ministries in which the interest in antibiotics is centered include: Ministry of Public Health, Ministry of Manufacture of Medicinal Preparations, Ministry of Food and Nutrition, Ministry of Fermentations, and Ministry of Heavy Industries, notably those branches which deal with biological supplies. Several institutes in the Academy of Sciences are interested in antibiotics, notably the Institute of Biochemistry and the Institute of Microbiology. Other organizations, such as the Institute of Epidemiology and Bacteriology, the Institute of Tuberculosis, the Institute of Physiology, and the Institute of Malarial Diseases, all of which are centered in or

around the VIEM (All Union Institute of Experimental Medicine), a special organization largely under the control of the Ministry of Public Health, are also interested in this subject.

The investigations on antibiotics carried out in these institutes and laboratories are partly of a research and partly of an applied nature. They embrace practically every branch of antibiotics studied in the United States and in Great Britain during the war period. The results of the survey can best be briefly summarized on the basis of each group of antibiotics.

1. *Fungi producing penicillin and penicillin-like substances.* Very little progress has so far been made in the Soviet Union in the manufacture of penicillin, although one or two pilot plants appear to be in the process of construction and several laboratories have concerned themselves with the isolation of penicillin-producing organisms, as well as with the production, isolation, and purification of penicillin and penicillin-like preparations. The small amounts of penicillin produced are primarily by the bottle process. Among some of the penicillin-like materials may be included penicillin-crustosin; this substance is a typical penicillin produced by *Penicillium crustosum*. It may also be of interest to mention here aspergillin produced by *Aspergillus niger*, which also appears to offer limited possibilities as an antibiotic agent.

2. *Spore-forming bacteria.* A tyrothricin-like preparation, which was designated as gramicidin S, was isolated in the Soviet Union. This preparation was found to be tyrocidine, one of the polypeptide constituents of the tyrothricin complex. It is being produced on a pilot-plant scale. Its efficacy in controlling wound infections does not appear to be greater than the original tyrothricin isolated in this country by R. Dubos. Another type of antibiotic was isolated in crude form from certain spore-forming bacteria. This was found to be water-soluble and was said to be similar in its properties to streptomycin. It was designated as colistatin. It is thermostable, is adsorbed on charcoal, and is removed by acid alcohol. It is active against various gram-negative and gram-positive organisms. Its limited activity in vivo renders this antibiotic of questionable practical importance.

S. VAVILOV
PRESIDENT, ACADEMY OF SCIENCES, U.S.S.R.

3. *Antibiotics of actinomycetes.* Several antibiotics have been isolated from actinomycetes and described under the names of mycetin, litmocidin, and one or two others. None of these appears to represent any great practical potentialities, since they are either not active in vivo or they have only a limited type of activity. They are primarily pigments in nature. Some work is also being done with streptothricin and streptomycin, cultures obtained from the United States being used.

4. *Antibiotic from blood.* An antibiotic

was isolated from red blood cells by a method similar to that commonly employed in isolating tyrothricin. This antibiotic was designated as erythrin. It is said to possess antibacterial properties similar to those of tyrothricin, although it is much less toxic. Its use is limited to surface applications for wounds and other infections.

5. *RK or KR factor.* This substance may possibly be classified with antibiotics, although its action is directed upon cancer cells rather than upon microbes. Although considerable publicity has been given recently to this substance, the general impression gained from a careful examination of the facts presented was that the claims have not as yet been verified and that the possibility of applying this factor to the treatment of human cancer is still very much open to question.

WHEN the second World War broke out, the major scientific institutions in the Soviet Union were moved away from their permanent locations to temporary positions in the East, especially in the Urals and in Central Asia. Although most of these institutions have been repatriated and are already beginning to function in a normal manner, certain difficulties, mostly of a purely physical nature or due to a shortage of trained personnel, were bound to occur. The progress of science is largely dependent upon the systematic collection of basic facts which govern natural processes. Once the normal course of scientific investigation is interrupted, there is bound to follow a period of adjustment which involves a certain loss of time in order to bridge the lost interval. A country that has suffered so much from the ravages of the war as has the Soviet Union is bound to show certain disorganized links in the progress of its scientific program. The most impressive thing observed by a visitor is the rapidity with which scientific recuperation has come about and how quickly the Russian scientists have made up for lost time. One must not be surprised, therefore, to learn that Russian factories are not as yet turning out large quantities of penicillin, or are not producing riboflavin by microbiological processes, or have not succeeded in establishing certain other industries which were developed in the United States and in Great Britain during the war. The surprise was to find that not only were the Russian microbiologists turning out large quantities of materials essential for combating important human and animal diseases, such as various toxins (including that of tetanus), vaccines (including that of typhus), serums, and other bacteriological preparations, but that they have also made an impressive start in the development of new fields, such as antibiotics.

APTITUDE TESTING

By JAMES F. BENDER

The National Institute for Human Relations, New York

MANY a veteran has come home from the wars to find himself—a captain or a major—definitely unfitted for his old clerical job. He now wants something commensurate in responsibility and compensation with what he had in, say, the Air Corps. How can he find out what he is really fitted for? In the Army he learned a good deal about aptitude tests. Perhaps their applications in education and industry will help him in his search for the right job.

The General Classification Test, given to several million Army and Navy personnel at induction, contained subtests of simple arithmetic, vocabulary, and analysis of cubes. The psychologist announced to the inductees that the test would measure "their ability to learn." Its origin goes back to 1908 when two French psychologists, Binet and Simon, published the results of a fifteen-year investigation of the question: How can we devise a more accurate method of identifying subnormal children in the Paris schools than the procedure based upon general observation?

Using empirical methods, they tried large numbers of tests upon many children of various ages to discover which test would differentiate children of various levels of mental ability. In that way they obtained *norms*, or averages. A youngster of six years of age who could pass the tests that had already been passed by a majority of six-year-olds was called normal in intelligence and given a mental age, or M.A., of six years.

Thus, the M.A. when put over the C.A. (chronological age) gives the I.Q., or intelligence quotient. If the result is 1, oftener written 100, the child is said to have normal intelligence; if his mental age exceeds his chronological age, then of course he is brighter than his peers, I.Q. 140 marking the beginning of the genius distribution. And vice versa, if a youngster of eight can achieve no more than an M.A. of six years, his I.Q. 75 classifies him among the less gifted, almost in the feeble-minded division. In order to succeed scholastically in a first-rate college, the student ordinarily needs a comfortable margin of 10 or more points above "normal" I.Q.

The Binet-Simon tests were soon adapted in America, the best-known revisions being those of Professor Lewis M. Terman, of Stanford University. During World War I the government asked a group of psychologists to devise tests to identify talented recruits for officer training. The result was the Army Alpha Test, based on the work of Binet-Simon and their successors and consisting of eight measurements: ability to (1) follow directions; (2) do simple arithmetic problems; (3) reveal practical judgment; (4) identify synonyms and antonyms; (5) unscramble disarranged sentences; (6) complete series of numbers; (7) see analogies; (8) reveal general information.

Questions are arranged from simple to complex: for example, in the arithmetic subtest, from "How many are 60 guns and 5 guns?" on up to "A certain division contains 5,000 artillery, 15,000 infantry, and 1,000 cavalry. If each branch is expanded proportionately until there are in all 23,000 men, how many will be added to the artillery?" Items in the fifth subtest are unscrambled and marked *true* or *false:* for example, "horses feathers have all;" "trees roses sea and in grow the;" "moon earth the only feet twenty from is."

The Army Beta Test was designed for illiterates and is composed of pictures, simple puzzles, number checking, mazes, and three other tasks, none of which depends upon reading ability.

These two tests were administered to approximately 1,727,000 men and were useful in eliminating the mentally unfit and identifying men who might make good officers because of their superior mental ages. The tests were indeed valid in predicting scholastic success, for among the men with a test rating above C+ only 8.65 percent flunked out of officer-training classes, whereas among men rating below C+, 58.27 percent failed their courses. Later in the war the scores were used to classify personnel according to the 275 occupations within the Army.

The tests also served as models for the numerous mental ability tests since used in education, such as the Scholastic Aptitude Test which is administered yearly by the College Entrance Examination Board all over the world to secondary-school students applying for admission to American colleges and universities.

Moreover, they were soon applied to business and industry. One of the first American companies to adopt intelligence tests chose 50 women to pack small, fragile articles. Careful records of their individual production were kept. At the end of a few weeks the most intelligent were either producing less than when they began or had quit; and, conversely, those with low scores increased their output and were satisfied with their work. High intelligence seemed to be deterrent to successful performance on that job; there was not enough challenge in it to sustain interest among the high scorers. Intelligence tests therefore have a negative as well as a positive value, for they are used to weed out those applicants who are too intelligent to become satisfactorily adjusted to a given job.

Intelligence, which may be roughly defined as the average of all a person's aptitudes, is tested by prescribing many different mental tasks. But certain work requires certain mental proficiencies. Take the job of bank teller, which requires above-average capacity in arithmetic. That is why scores on arithmetic subtests are weighted more heavily than those on vocabulary, for example, in screening applicants for tellers' jobs.

Another pioneer test developed out of the needs of the Army and Navy in World War I was Professor Robert S. Woodworth's Personal Data Sheet, designed to identify maladjustments of temperament. Also known as the Woodworth Psychoneurotic Inventory, it was used subsequently in education and in job placement. It formed the basis for the many later instruments measuring traits of temperament among children as well as adults. The Bernreuter Personality Inventory is widely used in business and industry. Its distinctive feature lies in its provision for measuring six traits of temperament on the basis of the same 125 questions. Each question is answered by *yes*, *no*, or *?* (meaning "Entirely unable to answer either *yes* or *no*").

Representative questions are: Do you daydream frequently? Do you get stage-fright? Have you ever had spells of dizziness? Are you troubled with the idea that people on the street are watching you? Do you ever argue a point with an older person whom you respect? Do you usually avoid asking advice?

After the scores are obtained by six different scales, ratings are assigned on (1) neurotic tendency, (2) dominance-submission, (3) introversion-extroversion, (4) self-sufficiency-dependency, (5) confidence-in-oneself, and (6) sociability. Bernreuter's description of one of the scales provides a sample interpretation:

> The individual who scores high on the B1-N (neurotic) scale shows a tendency toward neurotic

condition. Such an individual often feels miserable, is sensitive to blame, and is troubled by useless thoughts, by shyness, and by a feeling of inferiority. He shuts himself off from other people, he frequently daydreams, and worries both over things that have happened and over things that may happen. . . .

The individual who scores low on the B1-N scale is an emotionally stable person. He is rarely troubled by moods, worries, or by criticisms of others. He is self-confident, and is a doer rather than a daydreamer. . . .

Industrial psychologists report that job dissatisfaction is the greatest single cause of labor turnover, and approximately 60 percent of all job dissatisfaction is traceable to emotional maladjustments. The personality inventory is used, therefore, to detect emotional conflicts before the employee is placed. It also proves helpful in selecting salesmen and others whose human contacts require a certain temperamental type; for example, a proclivity toward extroversion is helpful in most kinds of direct selling.

A third use is exemplified in the rehabilitation of stutterers, whose inability to speak at will ordinarily results in feelings of frustration and kindred personality maladjustments. These can be isolated and their intensity estimated with the aid of personality inventories.

Closely related are the interest scales. A person may have the intelligence to succeed in mechanical engineering, but, unless his interests are related to those of successful mechanical engineers, he is unlikely to make good as a mechanical engineer. The Vocational Interest Blank, by Professor Edward K. Strong, Jr., was standardized on successful adults in some 38 vocations for men, ranging from advertising man to Y. M. C. A. general secretary; and on about half that number in vocations for women, including author, housewife, and lawyer.

A more recent scale measures areas of interest. The Preference Record, developed by Dr. G. Frederic Kuder, evaluates mechanical, computational, scientific, persuasive, artistic, literary, musical, social service, and clerical interests rather than interest in specific vocations. Different norms are provided for the sexes. The Preference Record is particularly helpful in guiding high-school youngsters who do not know where their interests lie.

Scales of general intelligence, temperament, and interests are of great importance, for these three bases of personality account in large part for personal success or failure. Specialized aptitude tests cover such widely different fields as law, teaching, selling, engineering, and medicine. They are composed of subtests dealing with tasks performed in the respective vocations. Some of them also include general information questions.

For example, in a widely used clerical aptitude test, there are subtests dealing with name lists and columns of figures to be checked, misspelled words to be identified, etc. In the George Washington University Test for Ability to Sell, one of the subtests deals with the ability to memorize names and faces. In the Ferson-Stoddard Law Aptitude Examination, a report of a legal case is studied for four minutes before the examinee is given the booklet in which questions are asked pertaining to the case. Such tests are ordinarily administered as part of a battery which includes the other kinds already discussed. They are tests of capacity rather than proficiency; that is, they are aimed at the innate abilities of the individual. Without her ever having been near a business office, a girl's score on a clerical aptitude test may indicate that she would make a good clerk.

Five particularly pertinent and important conclusions may be drawn from a study of aptitude testing:

1. "At least 50 percent of the population can succeed at least 50 percent of the time in at least

50 percent of the vocations." This knocks into a cocked hat the old belief that everyone is born into the world to do only one job well. Man, the most adaptable of all animals, can ordinarily succeed in a generous selection of the almost 20,000 vocations listed by the U. S. Census.

2. The "right" vocation is defined not only in terms of one's general intelligence, interests, temperament, and specialized capacities, but also by such important questions as: Does the vocation have a future? Is it overcrowded?
3. The right vocation is defined usually in terms of the long pull rather than the short haul, especially where gifted people are concerned. Where may I expect to be ten years from now if I follow the indicated educational and vocational advice? is a significant question when discussing results of aptitude tests.
4. Aptitude tests when administered and interpreted by qualified personnel can be of great help both in guiding the individual vocationally and in putting the employment policy of management on an objective basis. This does not mean that all aptitude tests are equally valid (there are more than a thousand of them!); nor are they a substitute for common sense; neither can they take the place of the seasoned judgment of trained interviewers. Rather, they are valuable adjuncts when used competently. Many companies report excellent results from using them in employee selection. The president of a representative company states: "Psychological and aptitude tests have succeeded in weeding out 85 percent of untrainable men who applied for work."
5. Aptitude tests can be of considerable aid to the person who has not yet discovered his capacities. Test results indicate that few people use all their capacities; that most of us can do certain things about three times more efficiently than certain other things; that among average specimens of human beings the most gifted possess about four times as much natural aptitude along given lines as the least gifted.

School children, especially, are in urgent need of more vocational guidance based on aptitude testing. Witness the statement attributed to Dr. Henry C. Link: "Our educational system is better equipped to give eight years of wrong kind of education to its pupils than eight hours of competent professional guidance."

It is well to keep in mind that there is no quick, easy way to discover one's aptitudes and qualifications; that vocational guidance based on controlled aptitude testing cannot be given through the mails; that ordinarily adults should spend 8 to 10 hours taking tests under controlled conditions if the job is done right, preferably in sessions lasting no longer than 2 hours.

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THE PRODUCTION AND RIPENING OF RED BLOOD CELLS

A SUMMARY OF DANISH STUDIES

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THE writer of this article was asked by the editor to present a summary of scientific work carried on in Denmark during the German occupation from April 9, 1940, to May 5, 1945.

Scientific work was never interrupted and not even seriously disturbed, but lack of chemicals and other materials, and especially lack of contact with the whole outside world, made itself increasingly felt.

An exhaustive survey of Danish work in all branches of learning is in preparation and will be useful for reference purposes, but I have preferred to summarize a single series of papers of outstanding merit and interest. The chief author of these papers is a young man, Claus Munk Plum, who had failed in the preclinical examinations in the Medical School of Copenhagen University and who was thereby barred from an academic career. His interest in research was so strong, however, that he accepted inferior positions in research laboratories, where he showed such aptitude for experimental work and obtained results of such importance that in 1944 the University could confer upon him the degree of Ph.D. The work here to be described was carried out mainly in the laboratories of the medicinal firm Medicinalco Ltd. (Chief: Erik Jacobsen, M.D.).

The first paper of the series, published in Danish in 1941, dealt with the reticulocytes in the blood of old persons as compared with younger.

Reticulocytes are young erythrocytes (red blood corpuscles), showing after special staining a network (reticulum) of threads inside the cell, which contains no nucleus. The relative age of such a cell can be estimated from the density of the network, which, from being very dense and filling most of the cell in the youngest stage, is gradually reduced to points and finally disappears. The idea underlying the study was to obtain, by counting the reticulocytes in proportion to the mature erythrocytes and their different stages in relation to each other, a measure of the regenerative power of the organism. The countings on 20 persons between the ages of seventy and ninety years showed a somewhat smaller total number of reticulocytes and a more pronounced dominance of the oldest stage, which could only mean that the cells ripened more quickly in old age. This result would probably have discouraged most people, but for Plum it provided a foundation for the hypothesis that the ripening of reticulocytes might be accelerated by some substance present in varying quantity in the blood.

An interesting procedure was worked out to test this hypothesis. The number of reticulocytes in normal blood is so small that it would be next to impossible to obtain a satisfactory accuracy in counting them, but when in a rabbit the number of red cells is reduced to 2–3 million per cubic millimeter by removing 30–50 ml. of blood each day, a very rapid formation of new cells will take place, and at any time some 20–30 percent of the circulating erythrocytes will be reticulocytes. When the cells are washed free of plasma, they are suitable for experimentation on the ripening process in vitro. Some washed cells were sus-

pended in the plasma under test, which could be taken from any animal, some in a solution of liver extract (a commercial product called Hepsol), and some as controls in a saline solution, kept for some hours at 40°C. Small samples were taken for differential counting at 2-hour intervals. It was found that both plasma and liver extract definitely increase the rate at which reticulocytes ripen into mature corpuscles.

A great deal of time-consuming and very tedious work was spent in establishing a fairly accurate measure to express the concentration of the chemically unknown ripening substance, but the success attained fully justified the exertions. Concentrations can be expressed in terms of a standard with an accuracy which is practically always better than 10 percent.[1]

The plasma of all the animals examined contains a ripening substance acting upon rabbit reticulocytes. Some of the substance is present also within the red corpuscles and is responsible for the ripening taking place when the corpuscles are suspended in saline. Plasma from the ox, which proved exceptionally constant and strong, was taken as the unit for concentration and to it was assigned the "ripening index" 1.00, while in practice a "Hepsol standard" of the same strength was used.

[1] The very large number of countings made in connection with these studies led to important consequences for the statistical theory. When Ruth Plum's paper was submitted to the Medical Faculty as a thesis for the M.D. degree, it was strongly objected to on the ground that the accuracy obtained was several times better than could be accounted for by Bernoulli's binomial theorem concerning the random distribution of marked elements in samples of a homogeneous population. Exhaustive tests, in which subjective influences were carefully guarded against and which included countings on enlarged photomicrographs of the cells concerned, substantiated the empirical results and conclusively demonstrated the fallacy of the theorem for countings of the large numbers here involved which can, as a matter of fact, be carried out with the accuracy empirically determined.

The rate of ripening brought about by a certain amount of ripening substance depends upon the temperature, according to a characteristic curve. Putting the rate at 40°C (the highest temperature examined) at 100, it is found to be 79–81 at 37°, 49–51 at 30°, and only 5–6 at 10°. As usual in biological processes, the Q_{10}, calculated according to van't Hoff, decreases with rising temperature.

A very interesting relationship was brought to light between the number of reticulocytes present in the blood of an animal and the quantity of ripening substance found in the plasma. In mice the lower the number of reticulocytes, the higher was the ripening index. In the ox no reticulocytes were ever found. The relationship found for the single species holds approximately even when average values for a number of species are compared, but only for adults having suffered no loss of blood. It does not hold in young growing animals, where both the reticulocyte number and the ripening index are increased, and loss of red cells, whether brought about by bloodletting or in any other way, is constantly followed by increases, usually both in the ripening index and in the number of reticulocytes in the circulating blood. When the function of the bone marrow is damaged, the consequent anemia may present a reduced number of reticulocytes, but even then an increased ripening index, indicating that the bone marrow is probably not the seat of formation of the ripening substance.

It is a very significant and interesting fact, worked out in detail by Ruth Plum, that the concentration of ripening substance present in the blood of women begins to rise *before* menstruation sets in and is further increased along with the actual small loss of blood.

Experiments on liver extracts, carried out by E. Jacobsen and Plum to try to isolate the active substance, led to the separation of a thermostable fraction, itself possessing

slight activity only but able to increase considerably the activity of the thermolabile fraction. Further purification of the thermostable fraction led to the isolation of a substance, identified by Inger Gad as tyrosine, which, while itself showing very slight activity, definitely activates the principle present in liver extract, but shows no activating effect on plasma. As tyrosine is practically absent from normal plasma it was assumed that a coupling of the unknown thermolabile factor with tyrosine, or a tyrosine-like substance, had already taken place in the plasma principle. The bold hypothesis was formulated that such a coupling might take place in the "reticulo-endothelial system," and experiments were made on rabbits in which this system was blocked by splenectomy and injection of 10 ml. of 1 percent trypan blue. This had the effect expected; viz., the amount of active ripening substance became in 2 days greatly reduced. It recovered in the course of a fortnight, but during all this time the normal ripening index could be restored by addition to the plasma samples of 0.01 percent tyrosine; that is, the thermolabile factor remained present in normal concentration, but could not become activated until the function of the reticulo-endothelial system had been restored.

Similar conclusions could be drawn from experiments undertaken by C.M. and Ruth Plum, in which 5 ml. of liver extract were injected intramuscularly into a rabbit and plasma samples examined for their ripening power at suitable intervals. These tests were made simultaneously, with and without the addition of tyrosine, which had a tremendous effect at first, but after 24 hours very little.

Later studies by Inger Gad, Jacobsen, and Plum made it very probable that the tyrosine does not act as such, but is partly oxidized in the reticulocytes to dopa and hallachrome, of which especially hallachrome shows a hundred times stronger activating effect than native tyrosine.

Ruth Plum, studying the concentration of ripening substance in a number of patients, found it definitely reduced in cases of pernicious anemia, in exophthalmic goiter, and in several patients with stomach complaints.

C. M. Plum examined a large number of organs by extraction of dried samples and also by pressing out sap from the fresh tissue to find the source of the thermolabile fraction. Some activity was found in all organs, and in most it could be increased by addition of tyrosine; but only in the stomach was the difference very marked, and the pylorus of pigs, especially, turned out to contain a maximal amount of the substance which can be activated by tyrosine, while the content of the fully formed substance is small only. This points definitely to the pyloric mucosa as the seat of formation of the thermolabile substance in the pig and to an interesting relationship with Castle's "intrinsic" factor against pernicious anemia, produced in the same tissue.

The war situation opened up the possibility of obtaining from the forensic postmortems fresh human stomachs, and it turned out that in man both the intrinsic factor and the ripening substance are produced mainly in the *fundus* of the stomach.

THE transformation of reticulocytes into mature erythrocytes is the final stage in the formation of red cells and takes place to some extent in the circulating blood as explained on the preceding pages. In adult mammals the earlier stages are found only in the red bone marrow, and the main problem is the formation of nonnucleated reticulocytes from the nucleated "erythroblasts." Plum began to study this in 1939 and published in 1941 a paper dealing, mainly from a histological point of view,

with the cell types found in the marrow, their mutual relations and numbers.

In 1942 a very valuable study of the production of red cells in the rat fetus was published by E. Jacobsen and Plum. It is well known that the initial mechanism of blood formation differs fundamentally from that obtaining later, and distinction is made between primitive nucleated erythrocytes (sometimes called megalocytes) with their parent cells "megaloblasts" and the final nonnucleated erythrocytes, produced from erythroblasts. The formation of primitive blood cells begins from the endothelium of the first fetal blood vessels and takes place somewhat later in several organs, especially the liver. The formation of final erythrocytes is, some time after birth, taken over exclusively by the bone marrow.

The chief merit of the paper by Jacobsen and Plum lies in the quantitative determinations, which allow an analysis of the formation, development, and retrogression of the different types of red cells.

Beginning on the eleventh day after impregnation, when the fetus weighs about 1 centigram, they find a total of 75,000 megaloblasts, but not yet any primitive erythrocytes. On the fourteenth day the number is 200,000, but they have produced 2.25 million nucleated erythrocytes, and at the same time the nonnucleated final erythrocytes begin to appear in small numbers. These increase rapidly, 10 being formed from each erythroblast between the fourteenth and fifteenth days, but 260 between the nineteenth and twentieth days, when the total number increases to 300 million, and the fetus, just before term, weighs about 2 grams. The megaloblasts disappear about the eighteenth day, and the number of nucleated red cells, which reached a maximum of 7 million on the sixteenth day, is on the twentieth reduced to 3 million.

In this paper there is further calculated for the adult rat a total production of about 9×10^9 erythrocytes per day, corresponding to 35–100 from each erythroblast in the bone marrow.

During the next two years all work was concentrated on the reticulocyte ripening principle, but Plum did not forget the problem of erythrocyte formation and the difficulty arising from the fact that there could scarcely be enough mitoses taking place to account for it. He took up the matter again in 1944 and constructed an apparatus for artificial cultivation of bone marrow modified from one made by Osgood. In this apparatus two concentric collodion sacs are suspended within a wider glass tube. In the innermost a flow of nutrition fluid is maintained to supply by diffusion through the collodion the cells outside. Between the two sacs bone marrow, obtained by sternal puncture from dogs, cats, rabbits, or man, is suspended in Ringer's solution and kept aerated to provide oxygen and remove CO_2. The outside space is filled with Ringer's solution which, serving as a kind of kidney to remove waste products, is changed from time to time. In these conditions at body temperature there will be a vigorous production of new erythrocytes, which can be followed by counting samples at suitable intervals of time. Such countings show that the mitoses of erythroblasts taking place, and also counted, could not account for more than 1 percent of the erythrocytes produced.

The mitotic activity could be stopped completely by the addition of colchicine to the suspension, but this had practically no effect on the rate of the red-cell production. It does not appear possible, therefore, that the generally accepted notion, that red corpuscles are formed by cell division with subsequent removal of the nucleus, can be correct.

In 1940 the Swedish nurse Lisa Boström suggested a formation of erythrocytes by

disunion of pseudopodia from the erythroblasts, and, since such a mechanism might explain Plum's result, he endeavored to observe it directly. A simplified small culture chamber was constructed on the same principles as the large one. Under the microscope one can see how a spherical erythroblast becomes oval with the nucleus at one end and how protoplasm flows toward the opposite end where suddenly a drop of it is detached and forms a small erythrocyte, which in the course of about an hour becomes a reticulocyte.

Further studies by means of the large cultivating apparatus, which are still in progress, go to show that the reticulocyte ripening principle also has an accelerating effect on the earlier stage of erythrocyte formation, and the tests made in this instrument on the blood and bone marrow of patients are coming into use for diagnosis.

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ABSORPTION SPECTRA

A shaft of gleaming marble has at best
But surface sheen. Its atoms scatter rays
With scant absorption. Pallor here betrays
An inner lack externally expressed.
But rosy quartz, a stone that is a nest
Of lovely hues, is one within whose maze
Electrons vibrate, capture light and blaze
Like clouds that sunset fires along the west.

Perhaps this truth may have for us a cue
If blind resistance makes us always spurn
What life would give, our souls are pale and drawn;
But if, with shutters wide, we face the new
And let experience deep within us burn,
Our lives will be as colorful as dawn.

F. MARION LOUGEE

OKINAWA AND ITS PEOPLE—II*

By PAUL E. STEINER

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Agriculture. Okinawa had an agricultural economy. Farming, perhaps more accurately described as gardening, was by far the most important occupation. Because the population was great, agriculture was so intensive that many calories of food were produced per acre. Unfavorable terrain was brought under cultivation by ancient but highly developed methods for preventing soil erosion, by irrigation, terracing, and devices for reclaiming land from the sea. The climate, fortunately, was favorable so that there were crops maturing at all seasons, and multiple crops per year were grown on some soil. The range of crops was further extended by water-impounding devices and irrigation. By these methods a country whose maximum productivity had been estimated at one time as capable of feeding a population of 300,000 had become nearly able to support 460,000.

The land in general appeared fertile, although there was some evidence of depletion from long use. Despite the heavy annual rainfall, little water ever flowed back to the sea. Crop failures sometimes occurred because of too little or too much rain at crucial times or because of typhoons which caused the coastal flats to be inundated with salt water, thus rendering the soil unusable for several years, or until sufficient salt had leached away. When rain fell after a drought at planting time, school was dismissed and everyone worked in the fields. The soil had a peculiar texture so that its angle of repose when very wet was low, as our engineers soon discovered. Terracing of entire steep hillsides was extensively practiced in the northern part of the island despite this handicap.

The farms consisted of only a few acres each and were subdivided into small plots according to surface contour. Each plot was devoted to a different crop, giving the countryside a garden-like appearance. Retaining walls were composed of rocks, or of soil covered by sod or by a dense hedge of shrubs, cycads, and large grasses. All excess water was carefully collected and conducted from one level to another as needed. Rice paddies were consequently found on hillsides as well as in the valleys.

Although differences were found from one part of the island to another, the acreage devoted to the different crops was estimated to be in the following descending order: sweet potatoes, beans, sugar cane, and rice. Other crops fell far below these four.

Because of the favorable climate, with no frost and with rainfall at all seasons, crops of one type or another were growing the year around. Two to three crops of sweet potatoes could be harvested each year from a plot of ground. Likewise, two crops of rice could be gotten from some land. Soybeans, however, yielded only one crop each year, and sugar cane required from one to two years before it was ready to be cut.

Although nearly every farmer had a few

* Continued from page 241 of preceding issue.

This article has been released for publication by the Bureau of Medicine and Surgery and the Security Review Section of the Office of Public Information of the U. S. Navy. The opinions and views set forth are those of the writer and are not to be considered as reflecting the policies of the Navy Department.

pigs, goats, and chickens, horses were found only on the larger farms, and most of the labor was done by hand. All the horses were small, some of them little larger than ponies. Cattle also were found only on the larger farms. They were large, black-and-white, and resembled Holsteins, although Durham cattle were formerly also popular. The goats were small and white. Hogs were of several standard breeds, both lard- and bacon-producing types. Both hogs and cattle were always confined to sty or stable. All offal from man and animals was carefully saved and together with ashes was used for fertilizer. Commercial fertilizers were introduced about 1900 to supplement the local supply, but because they were expensive they were not used in great amounts.

Sugar cane was the chief cash crop. It was pressed and processed either in small horse- or ox-powered presses or in larger community or commercial refineries. Other sources of cash income were surplus rice, soybeans, sweet potatoes, or animals.

Most of the farming was done by hand with crude tools, most important of which was an adz resembling a combination hoe, shovel, spade, and mattock. The more affluent farmers who owned an ox or small horse had a small two-wheeled cart and a crude plow. The cereals were threshed by flail or by a hand-powered thresher. "Weeds" were not tolerated, and the soil seemed free of weed seeds, as was indicated by the fact that few sprang up on deserted land or on freshly turned soil along roads and about military installations. On the other hand, sweet potatoes, tomatoes, and squash grew profusely and wildly as weeds in the most unexpected places, such as in the ashes of burned buildings and in the margins of shell holes.

Tea and coffee for local island use were grown in the northern hills at Tiara; they were said to be of mediocre quality. Dried soybean leaves were also used for brewing tea. Cotton was grown by some families for their own use. This was formerly an important crop until it became cheaper to buy Japanese machine-made cotton cloth. Tapioca, taro, lilies, and other root plants were grown on a small scale.

Nearly every farmer grew bamboo, cycads, shrubs, and trees in the hedge about the house, on boundary lines, along the larger terraces and irrigation ditches, and around outcropping rocks. The varieties of trees included conifers and numerous slow- and fast-growing, hard- and soft-wood species, some of which were scented or colored. They were selected for their usefulness as protection against typhoons and soil erosion, producing replacements of lumber for repairing buildings, and for making furniture. Banyan trees were trained to form an important part of many windbreaks. The bamboo was very important to these people: It was used in the construction of buildings, furniture, farm and kitchen utensils, fences, baskets, and screens. Another important plant was the cycad (*Cycas revoluta*) known as *sutichi* (Japanese, *soteisu*). It was planted to mark boundary lines and to prevent erosion of soil on terraces. The stem was dried and used for food and to make sago starch, the "nuts" were used for food, and the leaves were used to make brooms and for fuel. The coconut palm was rarely grown on this island because, according to the natives, the typhoons are too severe and the temperature in winter is too low. The pandanus, growing along the seacoast, was used to prevent soil erosion, to protect against typhoons, and to make rope, mats, and hats.

Commerce and Industry. The Okinawans claim that centuries ago they were an important commercial nation whose sailing vessels roamed the seas from Japan to the islands of the South Seas and intermediate places such as Korea, China, the Philippines, Indo-China, and Siam. Having

come under the domination of Japan, Okinawa became isolated when Japan adopted the closed-door policy in 1638. An agricultural economy, which has persisted to date, was then forced on the country, and commerce on a large scale was not resumed even after Commodore Perry visited Naha in 1853–54 on his way to and from Japan. Fortunately, sweet potatoes and sugar cane, two of the highest-yielding crops, were introduced in 1623, just before outside commerce ceased. The importance of this event is indicated by the shrine Yomochi-jinja (*jinja* = shrine) dedicated to the importer of these plants, one Gima Singo. Yomochi-jinja is located on Ono-yama, a small island in Naha Bay, which it shares with the Gokoky-jinja, a shrine dedicated to Okinawese soldiers.

By a combination of circumstances, including a favorable climate, fertile soil, fortunate choice of crops, and an industrious, frugal people highly trained in crafts, the Okinawans became self-sufficient at a fair standard of living. There are few known important mineral resources, little potential water power, and not enough forests to supply local demands. Commerce, then, centered about the products of the soil and the sea.

The foremost industry, that of making and exporting sugar, had sprung up in connection with agriculture. Though much of the sugar was made in small plants on the farms, a few large refineries were in operation, using coal imported from several small islands near Formosa. They operated from December to May. The largest plant, said to have been financed by capital from Formosan sugar interests, was located at Bisha-gawa near Kadena. The difficulties of transportation between the farms and the factories tended to limit the size of the latter.

The center of commerce, industry, shipping, and finance was the largest city and main seaport, Naha, the capital. Exports from this port were said to be approximately in the following order: (1) sugar; (2) fresh vegetables such as cabbage, tomatoes, cauliflower, etc.; (3) sea foods, including dried tuna fish, shark fin (to China), and cuttlefish; (4) Okinawan-style cloth made from *maou* fiber, and also a little silk and banana fiber cloth; (5) sake; and (6) cattle, of which 50 to 100 were shipped to Kobe or Osaka several times a month. Small amounts of silkworms, kitchen utensils, and lacquered furniture were also exported.

Imports were chiefly food, cloth (cotton and woolen), and machinery. Imported food included rice, canned crab meat and salmon, soybeans, and fresh fruit such as oranges, persimmons, plums, and apples.

Besides Naha, other cities having commercial interests were Shuri, Nago, Toguchi, and Itoman. The fishing industry was conducted from numerous small seaports, foremost of which were Itoman and Toguchi. Salt for local island use was made from sea water at Awasi, Baten Ko, and Naha. The best quality coral stone came from the Machinato, Minatoga, and Yontan regions. That obtained from the first two locations was fine like sandstone; the Yontan stone was coarse but tough and hard. Volcanic stone, used for millstones, came from the Kuba-saki region. Sake, of a special Okinawan type, was made at Naha, Shuri, and Nago. Vinegar for local use was made from the rice residue. Tile, used principally as roofing material, was manufactured by numerous small factories; pottery, including urns, was made at Tschoboya.

Electric current was generated at Nago and at Naha. From the latter a power line led through Shuri and Yonabaru to Sashiki. Sugar refineries used steam; a few small industries had gasoline engines.

Small shops and stores were found in all urban centers. Shopkeeping probably ranked in importance after agriculture and fishing. Shops were strictly licensed.

Transportation was by boat, foot, or horseback until about 1900, when two-wheeled carts were introduced. Later, narrow-gauge railroads were built from Naha to Kadena, Yonabaru, and Itoman. An electric railroad from Naha to Shuri lost money and was abandoned. Recently bus lines have been operated from Naha to many parts of the island, including the Motobu, Katchin, and Chinen peninsulas. There were said to have been only a few privately owned automobiles, but many people had bicycles. A few rickshas were in operation at Naha and Shuri.

The highway system was adequate to serve the needs of the people. Radiating in several directions from Naha were narrow concrete roads which extended to the adjacent towns. Beyond these was an extensive system of hard gravel roads from which branched the narrow cartroads already described. The principal hotel, at Naha, was said to have been modern and luxurious.

Economics. Capitalism replaced feudalism on Okinawa in comparatively recent times. Private ownership of the land was encouraged by the Japanese beginning about 1900. Trade was by cash rather than barter; the unit of currency was the yen, which was the same as that used in Japan. Taxes were said to be high.

Although, according to rumor, some of the old families were wealthy because of stored gold, the fortunes made in recent times were made mostly by Japanese. The main sources of cash were farm produce, fishing, wages, and relatives abroad. Unskilled labor brought 1.5 to 3 yen per day, and skilled workers such as carpenters earned from 6 to 10 yen. Most men were proficient at several kinds of work; thus, farmers commonly worked part time at fishing, lumbering, or in the sugar refineries.

The people were not sharply divided into social classes, but three general groups were recognized on the basis of wealth. In the third group were the farmers, in the second the professional men, storekeepers, and other villagers, and in the first the very wealthy. These included the brokers, especially those in rice, sugar, silkworms, and real estate, the large city merchants, and a few who returned with fortunes from other lands.

Economic pressure forced many to leave the island to seek their fortunes elsewhere. A large number of the young men and women went to Japan, where they worked in the industrial cities, especially Osaka. The doctors stated, incidentally, that many of these young people returned home with tuberculosis. Smaller numbers went to Formosa, to the Hawaiian Islands, to the Marianas, and to South America, notably to Peru and Argentina. Only a few came to the United States.

Arts and Crafts. The Okinawans were highly skilled in making most of the necessities of life and some of the luxuries. Consequently, although little was purchased, living was comfortable at a fair level. Their workmanship was utilitarian rather than decorative. In quality and artistry it lagged behind the best Chinese and Japanese work. No evidence was found that it had ever reached a higher level than that which prevailed just prior to the American invasion.

Engineering skill of a high order is exhibited by the soil-erosion, water-conservation, and irrigation systems. This was very soon discovered by anyone required to map and drain them for mosquito control. Although the tools such as saws and hammers appear crude, the skill and workmanship used in construction of the houses, with their elaborate system of panels and flexible, mortised frames fully able to survive typhoons and earthquakes, were quite remarkable. Skill in stonework was less impressive but adequate; coral and volcanic stone was dressed by hand and carefully fitted. Absence of freezing

and thawing made this type of construction very durable. The use of mortar was quite recent. Stone arches claimed to be 500 or 600 years old, built without a central keystone, survive today in Nakagusuku Castle. The furniture, usually simple and functional but sometimes elaborate and beautifully lacquered, also showed skilled workmanship. Cooking utensils were chiefly plain pottery or iron, but every family had chinaware of good quality and pleasing design for ceremonial and formal occasions. Pottery jars of all sizes and designs were very important in the kitchen and for storage of foodstuffs inasmuch as they could be effectively closed for protection against the prevalent dampness. Chibana pottery, named after the town where it was made some centuries ago, was especially prized. Its manufacture antedates the use of the potter's wheel; it is further characterized by a hard texture and a dull glaze which has a greenish sheen.

The Okinawans were excellent weavers. They made baskets, large hats, and trays from pandanus, bamboo, and other grasses and reeds; they wove ropes and baskets from rice straw and grass. Nearly every family produced silk cloth for home use. A distinctive, highly valued cloth known as *maou* was made from the fiber of a plant called *oube*, which resembles the new shoots of blackberry bushes. From banana fiber was constructed, among other things, a fiber cloth, some of which was exported. Rainproof capes were made from the fiber of the *shuro* palm. The women were skilled at making clothing from silk, plant fibers, cotton, and wool. Their creations from castoff military garments were wonders to behold.

The native dances were said to show evidence of Chinese and Japanese derivation with native additions. Professional entertainers sang native songs, recited poems, and produced plays and vaudeville. The principal musical instrument resembled an undersized banjo; it had five strings, and the sound box was covered by snakeskin. Organs were found in a few homes.

Education and Religion. The educational system on Okinawa consisted of grammar, intermediate, high, and special schools, all operated at government expense. The courses of instruction were six, two, and five years, respectively. Children of both sexes attended the same lower schools, but they were taught, if possible, in separate rooms. Most children went to school for six or eight years. To attend high or special schools it was necessary for most students to leave home. The special schools offered courses in agriculture at Kadena, fishing at Itoman, business at Naha, carpentry at Shuri, and teaching at Naha. For education at the college or university level, it was necessary to leave the island, and the number who did so was restricted by financial considerations. Most of them went to the Japanese universities, though a few went to Formosa.

English was taught in some of the schools, but only a few children were found who could speak it. The school building was the most impressive edifice in the villages; it was a long, one-story, wooden building, the width of one room, and usually built around two or three sides of a schoolyard. In the cities, also, the school was the outstanding building. Here the construction was of reinforced concrete.

The religion was an ancient form of family worship overlaid by a veneer of Buddhism and a lesser amount of Shintoism, all inextricably mixed. Man had a God-like origin, and each generation by inheritance partakes of this spirit. Man's spirit, after death, because of its God-like origin and nature, is worshiped by his descendants. Man is composed of body and spirit; after death the former disintegrates, but the remains are held in reverence. The spirit leaves the body and enters the hereafter (*Gusho*) where later it divides. Part of it

becomes, or merges with, God. The remainder is reincarnated within seven generations in some descendant.

These religious beliefs determined and found expression in two customs which were almost universally practiced among the Okinawans; namely, their burial ceremonies and the those centering about the family shrine.

Each family had a private tomb, or crypt. It was located on or near the house in the side of a hill or outcropping of rock. It was constructed of fitted hewn stone or, more recently, of concrete. The exterior exhibited a large, sloping, smooth, horseshoe-shaped top which was convex. In front this top was continuous with a vertical face, in the center bottom of which was a small entrance less than 3 feet square leading into the vault. The front face also had bilateral abutments from which low lateral and forward extensions formed the sides of a small square yard in front of the tomb [See cover, SM, January 1947]. The interior was small, dark, and damp. Across the rear was a series of ascending stone steps, or shelves, on which were located urns containing the ancestral bones.

The symbolism behind this form of tomb is that it represents the uterus, or abdomen, legs, and genitalia of Woman. Man comes from Woman (his ancestors), and after death he returns to them. This style of tomb, known as Kame-No-Ko ("Shell of the Turtle"), was imported from South China many centuries ago. While its present purpose is that of observation of traditional religious forms, it has a very definite practical advantage in an overpopulated country centuries old, where land and food are at a premium, in that it does not use arable soil. The accumulated graves of centuries as in Occidental cemeteries would by now deprive the people of a considerable percent of their land.

Modifications of this typical tomb took several directions. Poor families might use merely a simple cave with stone entrance. Sometimes the curves of the top were replaced by straight lines and flat surfaces. North of Nago the tombs are often small vaults standing apart out in the open. Here, also, a separate, slender, upright stone or concrete marker is found beside the low entrance of the tomb.

After death the body was placed in the tomb in a wooden coffin together with sake, tea, tobacco, slippers, needle and thread, and a paper hat. About three years later the tomb was unsealed and the bones were cleaned by women relatives and placed in an urn, which was labeled and placed on one of the rear shelves. Bones of husband and wife occupied one urn. All ancestors were thus filed in an orderly fashion. The only exception to this procedure was in the case of those who had leprosy or any other disease considered to be dangerous. These bodies were placed in separate crypts and remained untouched.

It was these tombs, together with new caves dug by the military especially for defense, which the natives and Japanese soldiers occupied during the campaign and which proved so formidable and costly to capture.

The family shrine was located in the main room of the house as already described. A cabinet with sliding panel front, 4 to 6 feet long, 3 feet high, and 2 feet deep, was surmounted by a smaller cabinet which contained in its center the family spirit name plates. The name plates were lacquered pieces of wood about 4 inches long, 1 inch wide, and .25 inch thick. They were mounted in two rows, upper and lower, within a small lacquered frame, often of exquisite workmanship, sometimes bejeweled, about a foot square, and mounted upright on a base. On each plate was painted the biographical data of one ancestor. Males were placed in the upper row and females below. These

family shrines are called in Okinawese, *eafay;* in Japanese, *eihaii*. After death a temporary name plate was painted in front with a false name provided by a Buddhist priest and behind with the true name. Prayers were offered once a week for seven weeks, after which this name plate was burned and a permanent, true name plate placed in the frame.

The shrine with its spirit name plates preserved in the minds of the people in a fresh and real way the lives and achievements of their ancestors. They could recite in great detail biographical data about their ancestors, remote as well as recent. Ceremonials, attended by the entire family, were frequently—sometimes twice each month or at anniversaries of birth, marriage, or death—held at the family shrine. At this time the shrine was decorated with vases of flowers and food and drink.

Because of the events believed to occur after death and the reverence in which ancestors were held, death was not dreaded. It was considered not a termination but a promotion. For many the hereafter promised more than they got from this life.

The homes occasionally contained a second type of religious symbol. This consisted of a Buddha enclosed in a small lacquered cabinet with hinged doors.

The larger towns and cities were said to have had Buddhist priests in attendance at temples, most of which were destroyed during the war. The largest and most famous was the Yenkaku-ji (*ji* = temple) at Shuri. Being located near the heavily defended castle, it was entirely destroyed. At Naha were located the Gokoku-ji and Tenlikyo-ji, both of which were near the famous Shinto shrine, Mami-no-ue ("Above the Waves"), the Hongwan-ji, and others. In Tomari, a suburb of Naha on the Shuri Road, were two famous temples, the Sogen-ji and the Amiku-ji. Still others were found at Futema and other towns. Some of these temples show Shintoist architectural features, just as some of the Shinto shrines were constructed in the Buddhist manner.

The smaller towns and villages had simpler Buddhist temples. They consisted of small concrete or stone structures located at sacred sites on some rocky eminence above the town, in a grotto or cave, or in a grove of ancient, stately trees. The temples were sometimes so small that the people did not enter but worshiped from without. They were built in the Chinese style, although some of them showed Shinto influences. An excellent example is found at Kashaba.

Shintoism was introduced from Japan in the seventeenth century. Architecturally, it was recognized by Shintoist additions or modifications on older religious structures and by numerous comparatively new, purely Shinto, shrines. These shrines were marked by *torii*, the peculiar double-barred wooden arch. They were erected on sites which from ancient times had been held sacred by the Okinawese, and honored various historical persons and benefactors.

In actual practice the people did not distinguish sharply between their ancient Animism, Chinese Buddhism, or Japanese Shintoism. Elements of each were intermingled in architecture and religious practice. The core of religious observation was in the home and in the family worship. The people attended the Buddhist temple several times each month or perhaps only once a year. The burial ceremony was usually according to Buddhist rites. Shintoism, the religion adapted to Japanese nationalism and militarism, was superimposed on, but less influential than, ancient Animism and Buddhism. It has been said that the people never accepted it as anything more than a recognition of political overlordship and that attendance at ceremonies by school children and others was sometimes compulsory.

THE STORY OF TWO ATOMS

By S. CHANDRASEKHAR

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IT IS now a matter of common knowledge that the nuclear model of the atom first proposed by Rutherford in 1911 is basic for all the natural sciences. On this model an atom is pictured as a minute positively charged nucleus, in which the greater part of its mass is concentrated, surrounded by a number of electrons. Under normal conditions, the number of electrons surrounding the nucleus is such as to make the whole atom electrically neutral. However, atoms with a net positive or negative charge are also known to exist. Thus, atoms with a positive charge can be obtained by simply removing one or more of the outer electrons of a neutral atom. Such *positive ions*—as they are sometimes called—can be produced in the laboratory under suitable conditions (usually in a spark discharge); they are also spectroscopically observed in the atmospheres of the sun and the stars where the high temperatures and low pressures prevailing are appropriate for their occurrence in the free state. On the other hand, *negative ions*, which in all cases known consist of one additional electron attached to a neutral atom, are of less common occurrence: indeed, whether a particular neutral atom can or cannot form a stable atomic configuration with an additional electron is a question not always easily answered. When the stability of a negative ion can be established, the corresponding neutral atom is said to have a positive *electron affinity*.

It is evident that on the Rutherford model, the simplest type of atomic structure will be represented by atoms (or ions) with one electron. The prototype of these is of course the hydrogen atom, which consists of an electron in the field of a proton. Singly ionized helium,[1] doubly ionized lithium, or triply ionized beryllium are also examples of one-electron systems. The next simplest type of atomic architecture will be represented by atoms (or ions) with two electrons: and the prototype of these is helium (named by Norman Lockyer after ἥλιος, "the sun"). Although other atomic configurations with two electrons (such as lithium, once ionized, or beryllium, twice ionized) are well known and have been produced in the laboratory, the case of the *negative hydrogen ion* consisting of an electron stably bound to a hydrogen atom is unique in that its stability has been established on purely theoretical grounds and it has been positively detected only in the sun's atmosphere. Indeed, it is remarkable that the story of the discovery and the identification of the two atoms, helium and negative hydrogen ion, should be so intimately connected with astrophysical studies relating to the constitution of the sun's atmosphere. And the story is worth telling since it illustrates once again the basic unity of all the sciences—in this instance, the unity of astronomical and laboratory physics.

IN THE year 1706 there was an eclipse of the sun visible in Switzerland, and there was one Stannyan who gave an account of what he saw at Bern. After describing the phenomena of the eclipse, he said, referring to the sun, "His getting out of eclipse was preceded by a blood-red streak of light." There are no photographic rec-

[1] An atom is said to be once ionized if one electron from the neutral atom has been removed, twice ionized if two electrons have been removed, and so on.

ords of the eclipse of 1706 (it was before the days of photography and astronomical spectroscopy), but we do have records of similar later eclipses, and in all of them Stannyan's observation has been confirmed. Indeed, it is now known that the origin of the blood-red streak which Stannyan first observed is to be found in one of the solar envelopes to which the name *chromosphere* was given by the English astronomer Norman Lockyer.

In the year 1868, during an eclipse of the sun visible in India, the spectroscope was first put into effective use for the study of the chromosphere by Lockyer, Pogson, and Janssen. In Figure 1 we have illustrated Pogson's original diagram of the spectrum of the chromosphere. It will be seen that in the spectrum there is a *bright line* appearing in the position of the dark (Fraunhofer) D line of the normal solar spectrum. Referring to this yellow line, Pogson said that it was "at D or near D." Almost the whole of the story of helium depends on this distinction.

After the eclipse of 1868 a method suggested much earlier for studying the chromospheric prominences without waiting for an eclipse was put into operation and has been extensively used ever since. The method consists in forming a telescopic image of the sun on the slit of a spectroscope so that the spectrum of the sun's edge and of the sun's surrounding envelope could be seen simultaneously. Consequently, exact coincidence or want of coincidence between the bright lines of the chromospheric prominences and the dark Fraunhofer lines of the normal solar spectrum could be ascertained at once. By using this method, it was shown that there was exact coincidence between the lines C and F ($H\alpha$ and $H\beta$, respectively) appearing as dark lines in the solar spectrum and the strong bright lines in the red and the blue-green regions of the spectrum of the "blood-red streak" (Figs. 2 and 3). On the other hand, no such coincidence was found between the D lines originating from the sodium vapor present in the solar atmosphere and the bright yellow line of the prominences (Fig. 4). The prominence line in this position has no connection whatever with the dark lines of the ordinary solar spectrum. The considerable significance attached to this divergence by Lockyer, Janssen, and others who had examined the matter is therefore understandable. The new line was accordingly called D_3 to distinguish it from the sodium lines D_1 and D_2, and the presence in the solar atmosphere of a new element, "helium," not terrestrially known at the time, was concluded.

A considerable amount of laboratory work was done with regard to the D_3 line.

But the substance emitting the yellow ray lay outside the range of our acquaintanceship, and seemed unlikely to be brought within it. That contingency, nevertheless, came to pass. In the

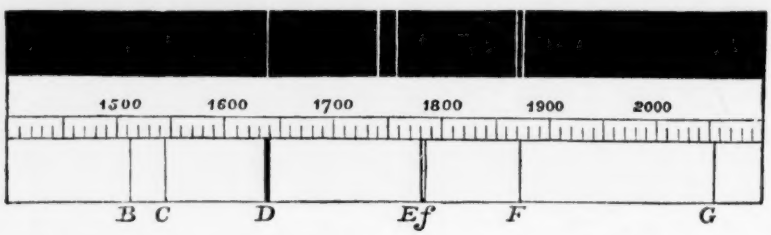

Fig. 1. Pogson's diagram of the spectrum of the sun's envelope during the eclipse of 1868. The bright lines which were seen are shown in the upper part of the diagram and the principal dark Fraunhofer lines in the normal solar spectrum are shown in the lower part.

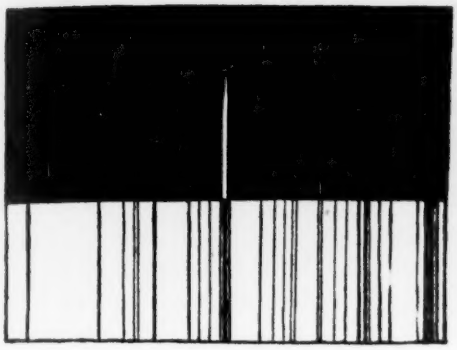

Fig. 2. The coincidence of the red chromospheric-prominence line with the dark line C(H_α).

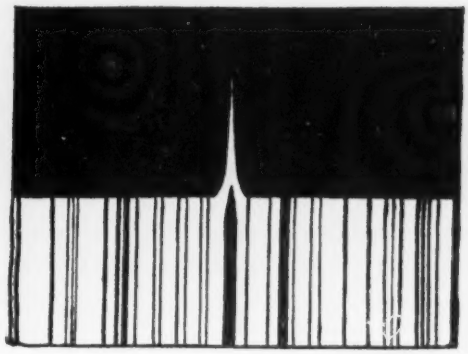

Fig. 3. The coincidence of the blue-green chromospheric-prominence line with the dark line F(H_β).

course of a search for compounds of argon, Professor Ramsay, at the suggestion of Professor Miers,[2] fortunately examined the reputed nitrogen occluded by the Scandinavian mineral 'clevite." This velvety-black stone, remarked as peculiar by Nordenskiöld and analyzed by Cleve, is a kind of pitchblende, composed of uranate of lead mixed with rare earths. The gas evolved from it at University College [London] gave a brilliant spectrum in which the prominence-line D_3 shone conspicuous. Helium was indeed captured! A beautiful confirmation of the identity was soon afterwards afforded. The golden line seen in the laboratory was perceived by Runge to have a faint close companion, and he declared that, unless the solar D_3 were also double, clevite-gas should be regarded as different from helium. The challenge was taken up on both sides of the Atlantic. Professor Hale on the 20th of June, 1895, and Sir William Huggins independently on July 10th, succeeded in resolving the prominence-ray into a delicate, unequal pair, and our possession of helium as a truly indigenous element was rendered incontrovertible.[3]

[2] Professor Miers, of the British Museum, recalled to Ramsay that W. F. Hildebrand, of the U. S. Geological Survey, had observed in 1889 that when certain uranium-containing minerals were boiled with sulphuric acid, a quantity of gas was evolved. The gas was, however, supposed to be nitrogen as its spectrum showed the characteristic fluting, and, consequently, it was not further investigated.

[3] Clerke, Agnes M. *Problems in Astrophysics.* London: Adam and Charles Black, 1903, 56.

THAT a neutral hydrogen atom, together with an electron, can form a stable atomic configuration was first conclusively proved by H. A. Bethe and E. A. Hylleraas, independently, in 1930. Since this is a unique instance in which the stability of an atom had been first established from theoretical considerations, it is of interest to see how Bethe and Hylleraas arrived at their conclusion.

On the quantum theory any arbitrary function of the coordinates of the electrons of an atomic system represents a possible state of the system; and the *probable*

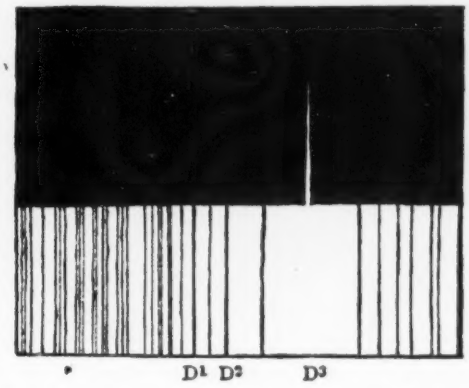

Fig. 4. The want of coincidence of yellow D_3 line with the dark lines D_1 and D_2 of sodium vapor in the sun's atmosphere.

energy (i.e., the energy which would be obtained as the average of many independent determinations on the system in the state considered) appropriate to the state in question can be found in a unique manner according to established rules of the quantum theory. If the atomic system considered has a stable ground (or normal) state then the function (*wave function*, as it is then called) describing such a state will lead to an energy which will be *less* than that given by *any* other function. This is one of the fundamental principles of the quantum theory. And we shall now indicate how this principle can be used to decide whether a given atomic system has or has not a stable ground state. We shall illustrate this by considering specifically the case of the negative hydrogen ion. The question is: Can an electron attach itself stably to a hydrogen atom?

We know that a proton and an electron can be stably bound together to form a hydrogen atom. And the energy of binding is 13.54 electron volts, meaning that an amount of work necessary for displacing an electron against a potential difference of 13.54 volts will be required for separating the constituents of a hydrogen atom, to rest, at infinite separation. We may accordingly say that the energy of the normal state of the hydrogen atom is −13.54 electron volts if we take as our zero of energy the state in which the charged particles constituting an atom are at rest at infinite separation. If the hydrogen atom together with an electron can form a stable atom, then its energy should be *less* than −13.54 electron volts: for, if a stable negative hydrogen ion exists, a finite amount of work should be necessary to separate the additional electron to infinity and leave a normal hydrogen atom behind with an energy of −13.54 electron volts. Consequently, *if* we can find *some* function which, according to the rules of the quantum theory, will lead to an energy less than −13.54 electron volts, we shall have proved the stability of the negative hydrogen ion: for the normal state must have an energy *lower* than any that we can find—unless we have been lucky enough to guess the correct wave function itself!

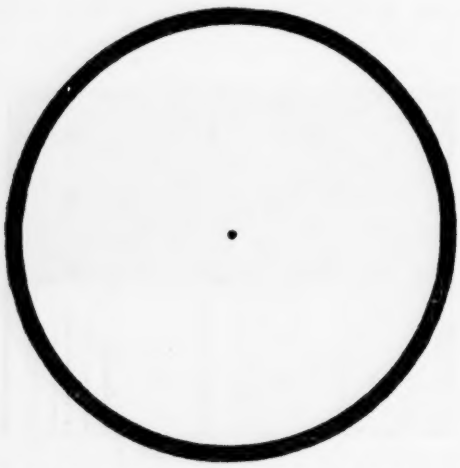

Fig. 5. A model of the hydrogen atom in its ground state. The electron will be found on the average at a distance of 0.79×10^{-8} cm. from the proton.

Bethe and Hylleraas were able to do precisely this: they were, in fact, able to isolate a function of the coordinates of the two electrons in the field of a proton which gave an energy of −14.24 electron volts indicating that the electron affinity of hydrogen is positive and must *exceed* 0.70 electron volts. A more recent theoretical determination has increased the value of the electron affinity of hydrogen to 0.75 electron volts; there are reasons to believe that this last value must be very near the true value.

Having seen that the negative hydrogen ion as a stable atom exists, we may ask, "What does it look like?" In one sense, it is not reasonable to ask such a question since on the quantum theory we cannot locate or individually identify the different electrons in an atom: we can only give the *probability*

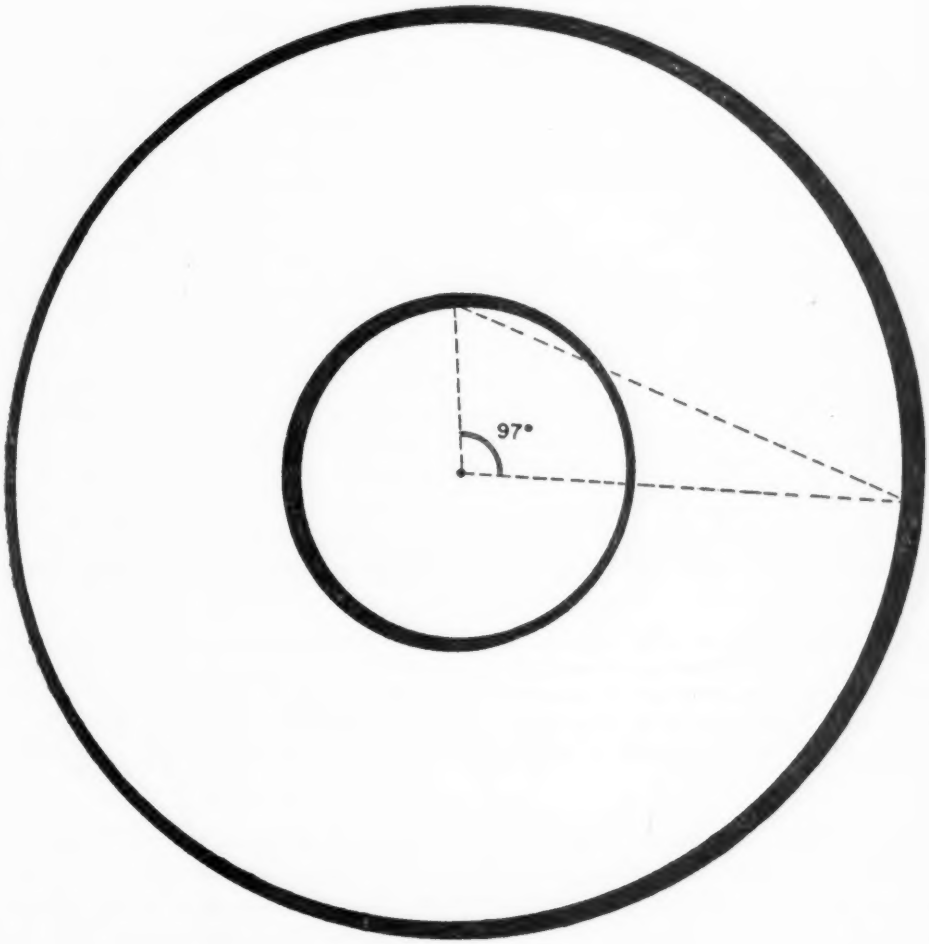

Fig. 6. A model of the negative hydrogen ion. The inner electron will be found on the average at a distance of 0.75×10^{-8} cm. from the proton while the outer electron will be found on the average at a distance of 2.02×10^{-8} cm. from the proton. The fact that the two electrons will be more often found on the opposite sides of the proton than on the same side is indicated by the unsymmetrical shading of the orbits. Calculations show that on the average the angle between the lines joining the proton to the two electrons will be about 97°.

that the electrons will be found in assigned positions. Nevertheless, we may ask where the electrons will be found on the *average*. In a hydrogen atom in its normal state, for example, the electron will be found at an average distance of 0.79×10^{-8} cm. from the proton (Fig. 5). With the same reservations, we may picture the negative hydrogen ion as in Figure 6, with the inner electron at a distance of 0.75×70^{-8}cm. from the proton—this is only slightly less than it is in the hydrogen atom—and the outer electron at a distance 2.02×10^{-8} cm. from the proton. However, the positions of the two electrons are correlated in the sense that the two electrons will be found more often on the opposite sides of the proton than on the same side: it is as though

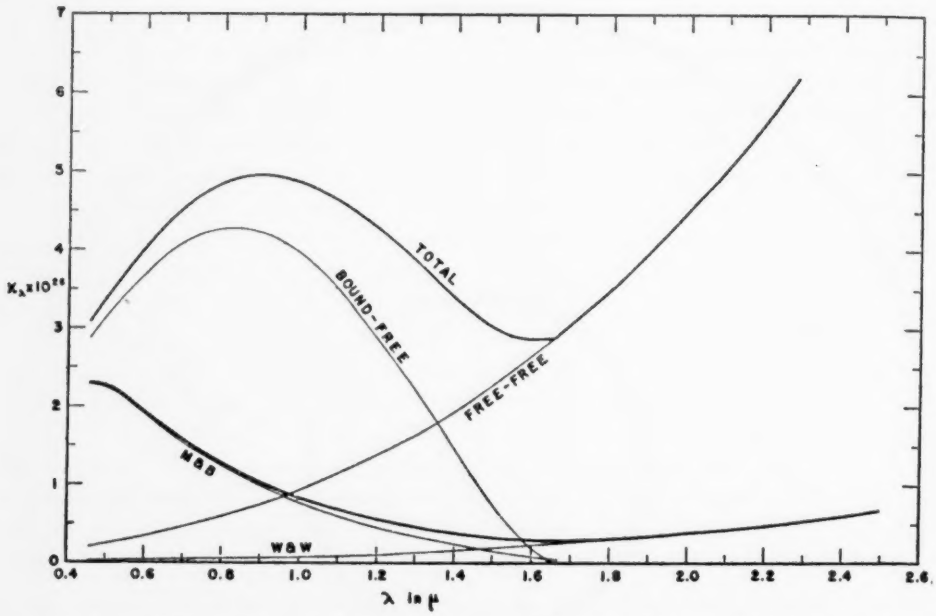

Fig. 7. The absorptive power of the negative hydrogen ion for light of various colors derived from physical theory. The curves are drawn appropriately for an atmosphere at a temperature of 6300° Kelvin and an electron pressure of one dyne/cm.^{2} and per neutral hydrogen atom. The curves *M* and *B*, *W* and *W*, and their sum are the results of earlier determinations by Massey and Bates, and Wheeler and Wildt. The results of more recent determination by Chandrasekhar and Breen are illustrated by the remaining curves.

the inner electron is accommodating enough to let the outer electron have an occasional glimpse of the proton to strengthen its binding!

We have indicated how the principles of the quantum theory enable us to determine the stability and structure of the negative hydrogen ion. But the atom has not so far been isolated with definiteness in the laboratory. We shall now show how its presence in the solar atmosphere has recently been inferred.

It is known from careful measurements of the *solar constant* (which gives the amount of radiant energy received from the sun, at the earth's distance, by a unit area normal to the line joining it to the sun) that the sun radiates 3.78×10^{33} ergs per second to the space outside. Since the radius of the sun is 6.95×10^{10} cm., it follows that each square centimeter of the sun radiates 6.23 $\times$ 10^{10} ergs per second. This *flux* of emergent radiant energy is not emitted in any particular wave length or color. The energy is actually emitted in all colors with a definite determinable distribution of intensity. This distribution of the emitted solar energy over the different colors has been determined with great precision by C. G. Abbot and his collaborators at the Smithsonian Institution. The experimentally derived distribution is illustrated in Figure 10 (curve 2). It is evident that we should be able to infer from this energy distribution something significant about the constitution of the solar atmosphere, particularly about the relative effectiveness with which the material composing the solar atmosphere absorbs light of various colors. For the radiation we receive at any partic-

ular wave length (or color) is the resultant of the radiation of this color emitted by the layers of the solar atmosphere at *all* depths: only the weight with which the deeper layers contribute to the emergent intensity will be progressively reduced on account of absorption by the intervening material. The effectiveness with which the deeper layers affect the emergent radiation in any particular color will therefore depend on the absorptive power of the solar material for radiation of this color. Thus, if the absorptive power of the solar material is less in blue-green than it is in yellow-orange, then in the blue-green region of the spectrum we should effectively see to greater depths in the solar atmosphere than we do in the yellow-orange region; consequently, the radiation in the blue-green region must be more characteristic of the deeper layers at a higher temperature than the radiation in the yellow-orange region, which will be more characteristic of the higher layers at a lower temperature. It is clear that in this manner we should be able to infer the relative absorptive power of the solar atmosphere for radiation of different colors. This was first done by E. A. Milne in 1922, and his results have been generally confirmed and extended by later investigators. These investigations show that the absorptive power of the solar atmosphere increases by a factor of the order of two as the wave length increases from 4,000 to 9,000A; beyond λ 9,000A the absorptive power decreases by about the same amount until we reach λ 16,000A in the infrared; and the indications are that, as we go further into the far infrared, the absorptive power again increases.

For many years one of the principal problems of astrophysics was to determine the source of continuous absorption in the solar atmosphere which will show the behavior we have described. All efforts in this direction failed until R. Wildt suggested in 1938 that we should perhaps look for the source of continuous absorption in the solar atmosphere in the presence of negative hydrogen ions in the atmosphere. The

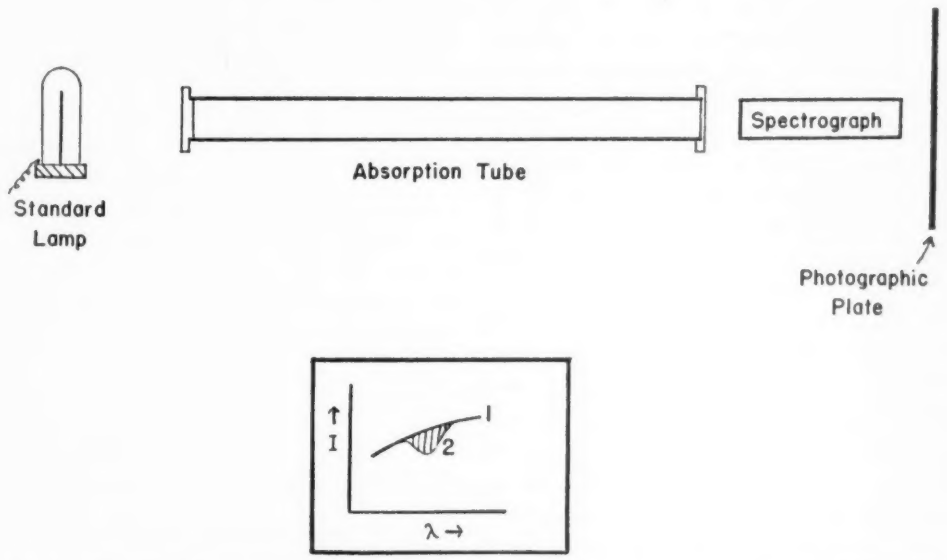

Fig. 8. The schematic experimental arrangement used in laboratory investigations for the spectroscopic identification of an unknown gas.

Fig. 9. A schematic drawing of the sun's photospheric layers.

grounds for the expectation were simply that in the solar atmosphere there is an abundance of neutral hydrogen atoms and there is also a supply of free electrons from easily ionized atoms such as sodium, calcium, magnesium, silicon, and the rest; and, in view of the positive electron affinity of hydrogen, some of the electrons will attach themselves to the neutral hydrogen atoms present. This suggestion of Wildt was taken up with great enthusiasm by other astrophysicists. But, before definite conclusions could be drawn, the absorptive power of negative hydrogen ions for radiation of different colors had to be derived, again from physical theory. The first determinations of the absorptive power of the negative hydrogen ion by Massey and Bates and others were disappointing. As will be seen from Figure 7, these early determinations were at complete variance with the astrophysical demands. However, it was soon realized that a reliable determination of the absorptive power of the negative hydrogen ion is an exceptionally difficult problem on account of its relatively very large size. The difficulties have now been overcome satisfactorily, and the new determinations are entirely in accord with the solar data. Indeed, we shall now show how, with the help of the newer determination of the absorptive power of the negative hydrogen ion, we can actually *see* the presences of these atoms in the solar atmosphere.

Let us recall how we normally identify any particular gaseous substance by its absorption spectrum in the laboratory (Fig. 8). First, we have a standard lamp which emits radiation in a known manner in all wave lengths (curve 1, Fig. 8). Next, we introduce the unknown gas in an absorption tube and we let the light from the standard lamp pass through the absorption tube and analyze the transmitted light spectroscopically. By comparing the intensity distribution in the transmitted light (curve 2, Fig. 8) with that emitted by the standard lamp (curve 1) we get the *absorption curve* of the gas. It is in terms of this *absorption* that the identification of the gas is made. Similarly, the radiation from the deeper layers of the sun passing through the outer (photospheric) layers gives rise to the observed emergent continuous spectrum of the sun (Fig. 9 and curve 2,

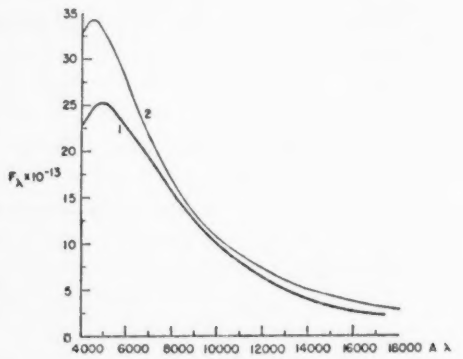

Fig. 10. The intensity distribution in the emergent continuous spectrum of the sun (curve 2) and the expected distribution if the absorptive power of its atmosphere is independent of color (curve 1).

Fig. 10). It would seem that the analogy with the laboratory experiment breaks down at this point since we do not seem to have the analogue of the standard lamp. However, we can construct a theoretical standard of reference in the following way: Suppose that the absorptive power of the solar atmosphere is the same in all colors; in other words, suppose it is *gray*. We can then predict in a relatively straightforward way what the intensity distribution in the emergent radiation should be. This is indicated by curve 1 in Figure 10. We use this as our standard of reference. The difference in curves 1 and 2 in Figure 10 must be due then to the *variation* of the absorptive power of the solar atmosphere with color. We may, if we like, call this difference the *solar absorption curve*. This is shown as a series of points in Figure 11. Now, we can compute what the solar absorption curve should be if the absorbing mechanism is provided by the negative hydrogen ions. This is shown as the full-line curve in Figure 11. It is seen that the agreement between the observed absorption curve and that to be expected from the negative hydrogen ion is very satisfactory; indeed, so satisfactory that we are justified in saying that this atom has been detected spectrophotometrically in the sun's atmosphere.

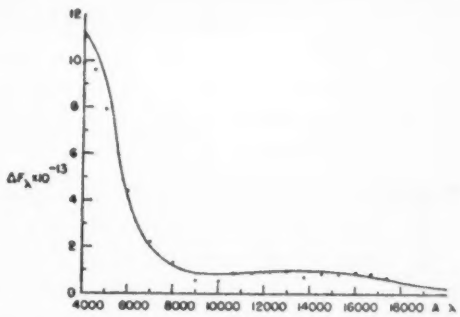

Fig. 11. A comparison of the observed "solar absorption curve"—the difference of curves 1 and 2 o Figure 10—and that to be expected on account o the presence of negative hydrogen ions in the solar atmosphere. The former is indicated by dots while the latter (derived from a recent investigation of Chandrasekhar and Münch) is shown by the full-line curve.

The story of the negative hydrogen ion we have just concluded has, in some respects, a plot which is strangely the reverse of that of helium. In the case of helium, the presence of a new element in the sun was first concluded on the strength of spectroscopic evidence, and it was only a quarter of a centry later that its terrestrial existence was established. In the case of the negative hydrogen ion, on the other hand, its stable existence was first established on theoretical grounds, and it was only some 15 years later that its presence in the solar atmosphere was concluded, on the strength of spectrophotometric evidence.

The stories of helium and negative hydrogen ion we have told have a moral. It is, however, the same as it was 50 years ago when Norman Lockyer, concluding the story of helium, wrote, "The more we can study the different branches of science in their relation to each other, the better for the progress of all sciences".

THE WEAPONS OF PANACEA

By H. B. VAN DYKE

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THE title of this article will mystify some readers. Panacea was a goddess whose name has fallen into serious disrepute owing to the common practice of making it synonymous with the impossible—a remedy for all diseases and, hence, a quack medicine. In the hope that I can contribute to the abatement of her unjust treatment, I wish briefly to give one version of her origin, to describe some of the methods by which her armory has been equipped, and to emphasize how carefully her fascinating new weapons must be used by her votaries. According to some accounts, Aesculapius, the god of medicine, had several daughters, of whom the most famous was the goddess of health, Hygeia. My title refers to a less well-recognized daughter, Panacea, the goddess of healing, whom we may regard as the patroness of therapeutics, just as Hygeia can be considered the patroness of preventive medicine. I cannot discuss all the varied weapons from which Panacea may choose if she is to be a healer of all ills. My chief interest is in the action of drugs, and I shall direct attention principally to these therapeutic weapons.

Attempts to cure or to prevent disease by plants or by animal tissues unquestionably were undertaken for ages before any records are known to us. Probably some guesses as to prehistoric methods can be furnished by the practices of primitive peoples today who rely on magical rites and peculiar remedies for recovery from disease. Moreover, as MacKinney has pointed out, even highly developed civilizations such as those of Egypt, Greece, and Rome were content to accept drugs prepared from plants, animals, or minerals although their therapeutic value was determined only by superstition and crude empiricism. Some remedies, not truly different from these, occasionally survive even today among isolated ignorant groups in countries, including our own, which regard themselves as most civilized. I can illustrate how superstition and irrational empiricism were practiced by quoting MacKinney's description of the manner in which the royal physicians treated King Charles II during his last illness:

> . . . a pint of blood was extracted from his right arm, and a half-pint from his left shoulder, followed by an emetic, two physics, and an enema comprising 15 substances; the royal head was then shaved and a blister raised; then a sneezing powder, more emetics and bleeding, soothing potions, a plaster of pitch and pigeon dung on his feet, potions containing 10 different substances, chiefly herbs, finally 40 drops of extract of human skull, and the application of bezoar stone; after which his majesty died.

If we are better off today, we owe this change to the scientific revolution of the past century and a half. It is true that important drugs were first discovered by primitive people or by careful appraisal of medicinal folklore. Cinchona bark containing quinine is an example of one, and digitalis is an example of the other. The use of cinchona bark enabled the seventeenth-century English physician Sydenham to distinguish malaria from other fevers, although its rational use had to follow Laveran's discovery of the malarial parasites in 1880. Another English physician, Withering, in 1775, identified digitalis, or foxglove, as the active therapeutic agent in the secret complex prescription of medicinal herbs of an old woman in Shropshire. Yet Withering used the drug for treating

dropsy (edema), and its rational use, still not completely understood as a remedy for the diseased and failing heart, has been a matter of gradual development since late in the nineteenth century. Thus we can conclude that the growth of all the sciences, occurring as it has largely since 1800, has determined the growth of scientific medicine which, in turn, alone has enabled us to employ drugs with an understanding of their action.

Until the middle of the nineteenth century, therapy by drugs could add little to the self-respect of the conscientious and critical physician. It is true that much earlier a beginning had been made in attempts to describe without equivocation the remedies which physicians use. At the end of the fifteenth century, the city of Florence introduced a *Nuovo Receptario.* As Urdang points out, this may be regarded as the first-known European ancestor of the modern pharmacopoeia in the sense that it contained standard descriptions of pharmaceutical preparations which had to be used by all physicians and pharmacists in the political unit in which it was promulgated. However, official or unofficial descriptions of the complex mixtures commonly prescribed, although a step forward, contributed little to therapy. A popular account in *Fortune* mentions that Oliver Wendell Holmes could proclaim in 1860 that nearly all the drugs then in use should be thrown "into the sea where it would be all the better for mankind, and all the worse for fishes." The successor of the ancient apothecary became the vendor of patent medicines who "put more time, money and imagination into the package than he ever put into the contents, which might be and often were thrown together out of the cheapest nondescript materials." Leaders like Cushny recognized that not a few respected drugs had no more therapeutic virtue than the nostrums and demanded scientific evidence to support their continued use. As a result, deletions from official lists were made at an accelerated pace. Only recently has recognition of the need to subject every important new remedy to rigorously controlled therapeutic tests begun to be general.

Before the nineteenth century was half completed, ether had been introduced as a general anesthetic, and the first laboratory of pharmacology formally dedicated to the scientific study of the action of drugs had been founded. As physics and chemistry flourished, a whole group of biological sciences was established, offering concepts and methods with which drugs could be scientifically evaluated. In this regard physiology, biochemistry, and bacteriology are of special importance. In their development and in their relation to clinical medicine, pharmacology and another newly founded biological science, pathology, have several attributes in common. The early growth of both followed and depended upon the founding and development of sister preclinical sciences, such as physiology and biochemistry for pharmacology, and anatomy and bacteriology for pathology. Both have close immediate ties with clinical medicine—pharmacology with therapeutics, and pathology with diagnosis. Although both are studied in the spirit of "pure" science, they are conscious of inescapable obligations to clinical medicine. Both sciences are interested in deviations from the normal caused in one case by drugs, and in the other by disease. In the pursuit of this interest, both sciences have repaid a measure of their continuing debt to sister sciences. For example, pharmacology not only has furnished chemical tools for the use of the physiologist or biochemist but also has itself discovered substances of great physiological importance.

Shortly after the first medicinal use of a synthetic organic chemical, ether, Perkin discovered that dyestuffs can be made from aniline (1856) and the foundation of the

great scientific expansion and industrial exploitation of organic chemistry was laid. However, only during the sixty years just past has it been realized what immense contributions synthetic organic chemistry can make to therapeutics. This new source of drugs is limited only by the scientific insight, the ingenuity, and the industry of the organic chemist and the pharmacologist. Within a century, many of Panacea's most powerful weapons unknown throughout history in terms of the traditional *materia medica* of drugs of plant, animal, and mineral origin have been devised and made in the laboratory. A parallel development has been the isolation and structural characterization of naturally occurring therapeutic agents such as alkaloids, glycosides, and hormones. Lastly, metals such as arsenic and antimony have been shown to confer unique and specific chemotherapeutic properties when incorporated into larger molecules by the organic chemist. Recently, new methods of radiation therapy have been made possible by the use of radioactive isotopes furnished by the physicist. Three of these, radioactive iodine, radioactive phosphorus, and radioactive sodium, are already on trial therapeutically. Also, it is apparent that tracer elements like heavy nitrogen (N^{15}) or radioactive carbon (C^{14}) can be incorporated into drugs so that these drugs or their degradation products can be specifically identified.

THE foregoing is largely historical prologue. It may be of interest to illustrate by a few modern examples how new drugs are discovered and the great care which must be exercised in demonstrating their value in human disease. However, we should first give brief consideration to a few principles and methods to be regarded as essential in the investigation and introduction of drugs. Were there not efforts to prevent animal experimentation, I would feel it a reflection on the reader's intelligence to mention that a new drug usually cannot be discovered or safely used in human disease without humane and properly controlled experiments on organisms ranging from bacteria to primates. In the final clinical trials, man is the experimental animal; under these circumstances control groups often can be set up only incompletely or with great difficulty. In contrast with the therapeutic lore preceding our more scientific era, analysis of the therapeutic effect of a drug is simplified but not made simple by using so far as possible single drugs of known composition. Obvious as this practice will appear, it is well to remember that it had little recognition for centuries. An extreme example of a complex prescription not worth the labor of evaluation is the antidote of Mattioli containing 230 ingredients. Specificity of action is a highly desirable attribute of a drug since it leads to a corresponding increase in precision of therapy and may immensely facilitate diagnosis. The number of drugs with high specificity is small, and we often describe unwanted or harmful actions as "side effects." Penicillins may be described as highly specific antibacterial drugs in the sense that toxic or undesirable effects are rarely associated with their proper use. On the other hand, all general anesthetics have limitations of one kind or another which reduce their specificity. The harm that drugs can do, even though often perceived early, may be subtle and lead to consequences which some physicians are loath to recognize. For example, the use of sulfonamides for trivial complaints may sensitize the patient so that the later use of a sulfonamide leads to serious toxic manifestations when the drug may be required for a serious bacterial infection. Inadequate dosing may be worse than no therapy if a strain of bacteria or parasites resistant to the drug survives and is allowed to propagate itself.

I mentioned earlier that the scientific study of drugs may lead to discoveries of great physiological interest or furnish chemical tools for the physiologist. Hunt and Taveau discovered the truly remarkable effect of acetylcholine in lowering the blood pressure following attempts to identify the substance in adrenal and brain extracts which had a depressor action. Now, years later, it is universally agreed that this substance plays an important part in the physiology of the nervous system. Alloxan is an example of a compound used as a physiological tool: it can specifically destroy the insulin-secreting cells of the pancreas and thus cause experimental *diabetes mellitus* without surgical intervention.

Also of great interest are unsuspected properties of drugs leading to new discoveries of real practical importance. If the MacKenzies and McCollum had not noticed the goiters in their animals receiving repeated doses of sulfonamides, the discovery by Astwood of the much more useful antithyroid drug, thiouracil, probably would not have been made. Dale described how a wrong hypothesis can also enable the alert investigator to forge ahead. The diguanidine, Synthalin, is a drug which causes the blood sugar to fall and was once thought to be a possible substitute for insulin. V. Jancso, knowing that trypanosomes utilize much sugar when living outside of the body, administered Synthalin to trypanosome-infected animals. Since the parasites disappeared, he concluded that lack of sugar in the blood was responsible for their death. However, Lourie and Yorke satisfied themselves that insulin in vitro does not have a significant lethal effect but that Synthalin can kill trypanosomes in very great dilution. King, Lourie, and Yorke were thus led to the discovery of other diamidines which are used for the treatment of African sleeping sickness and kala azar. Some drugs of extreme importance have been discovered by laborious systematic pharmacological examination of a host of organic compounds. Atabrine and the newer antimalarials typify this method of research, which requires the immense funds of large industrial establishments or government agencies.

Today we believe ourselves to be more critical of the claims made for new drugs than were our predecessors and we are attempting to set up machinery for clinical tests under scientific control. However, the uncritical still furnish material for a history of useless drugs which now appear to be more respectable because of a more or less accurate chemical description. The critical physician of a generation or more ago has been called a therapeutic nihilist. Like Trousseau, who remarked, "Always use the new drugs while they still have power to heal" (Brown), he could also be a therapeutic cynic. Brown also cites examples of the manner in which new drugs are found to be beneficial to the extent that the physician believes in their merit. During the period of medical enthusiasm, results can be highly successful; as doubts assail the therapist, only an occasional patient is benefited; finally, the physician is frankly skeptical, and the previously valuable drug becomes virtually useless. Suggestion can give temporary life to a valueless remedy. Only controlled critical repeated observations can insure a respectable longevity for a drug. A new drug developed in the laboratory must be supported by pharmacological and toxicological data; its early clinical acceptance likewise requires similar data from human trials. Some truly useful drugs, such as colchicine for the treatment of the acute pain of gout, lack what some would call "laboratory" support. However, the number of such remedies is unquestionably declining as the bulk of new drugs now flows from the laboratory.

On the basis of the production data of

insulin, Clark estimated that about a generation is required for the full utilization of a genuinely useful drug. Although the decade just ending is manifestly abnormal, it appears that the tempo of the rise, decline, and ultimate stabilization of an important therapeutic agent has been greatly accelerated. This can even furnish amusement to the laity when the cartoonist depicts a druggist holding a vial before a prospective customer and remarking, "It has been a wonder drug for over a week now." Under the spur of government-sponsored research and production, penicillins within a few years have displaced sulfonamides in both medical and lay favor, although sulfonamides first received favorable recognition only in 1935 and the peak of production in this country, 9,860,000 pounds, was reached in 1943. A chapter could also be written on the influence of popular articles concerning drugs on the therapeutic practices of the average physician. For example, it appears today that only a strong and honest physician can resist the patient's demand that penicillins be used for every ailment: he risks ostracism by his patients and foregoes easy profit to himself.

The modern physician has received an elaborate training in the basic preclinical medical sciences. On this foundation he builds during the remainder of his career in clinical medicine. With this background of training and experience, the alert clinician knows that if he is to use one of the many weapons of Panacea to prevent, alleviate, or cure disease, he must choose his weapon wisely and use it to its full advantage.

PLUTONIUM—NAMED FOR THE GOD

Out of the void, the fear, the terror's breath
He rose titanic from those regions dank
Where darkness reigns—darkness and grief and death
Pluto, grey guardian of the lifeless rank.
Yet men conceived him in another guise
His not alone the grim and bleak design,
Wearing an aspect gracious and benign.
And now at world's end, Man, the child, the fool,
Sudden in strength, cleaving the very sod,
Has forged himself a wonder-working tool
Plutonium—and named it for the God.
O Man, creator turned, lift up your voice
Abundant life or death—and yours the choice.

MARTHA E. MUNZER

HOW THE JUNIOR ACADEMIES OF SCIENCE OPERATE

By JOHN W. THOMSON, JR.

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EVERYWHERE today one reads of the part the young scientists must play in the world of tomorrow. The need for them is great and a place is assured for them, but what is being done to find them?

Back in 1919 a movement began in Illinois, flowered briefly, was almost submerged, and then in 1928 with great vigor began to show its real importance. Always depending upon volunteer enthusiasm and interest, the junior academy movement is rapidly becoming a force to be reckoned with in the production of young scientists. In the junior academies the senior membership is finding the wellsprings of continued growth and leadership.

When the Wisconsin Junior Academy was in process of being organized, information on the operation of junior academies was needed. In order to obtain up-to-date information, a questionnaire was sent to all Science Clubs of America Cooperators and junior academy sponsors. Through the generous help of many people, the information in this article is made available.

Probably the real start of the junior academy movement came with the reorganization in 1928 of the Illinois Junior Academy to include the participation of the high-school students in an academy meeting. All the active junior academies have since successfully followed this pattern of having at least one meeting a year with the senior academy. Fairly soon after the reorganization of the Illinois group, other junior academies were founded: Indiana and Kansas in 1930, Iowa in 1931, Kentucky and Pennsylvania in 1933, Alabama and West Virginia in 1934, Oklahoma and Texas in 1935, Missouri and St. Louis, Mo., in 1936, Minnesota in 1937, Florida in 1939, Virginia and Ohio in 1940, Tennessee in 1943, Wisconsin in 1944, and Georgia and Michigan in 1946. With this the roll cannot really be called complete, for the list should include organizations whose activities embrace the same field and philosophies as the junior academies. In North Carolina there is the High School Committee of the North Carolina Academy of Science; in Maine the Maine Principals' Association has sponsored a Statewide Science Fair and Congress; in New Jersey the Newark Museum sponsors a Science Congress; in Rochester, N. Y., the Junior Science Club Committee of the Rochester Academy of Science is making arrangements to sponsor opportunities for the science-minded youngsters of that area; in western Pennsylvania the *Pittsburgh Press* sponsors a year-round program for young scientists with a Science Fair; in Rhode Island the *Providence Journal* supports a similar Science Fair; and in New York the American Institute of the City of New York has sponsored Science Fairs at which projects were exhibited.

Two main sources of leadership have helped foster this rapid development. The Academies Conference of the American Association for the Advancement of Science under the leadership of Dr. Otis W. Caldwell has carried the burden of helping prospective and active junior academies since the Cleveland meeting of 1930. More recently, Science Clubs of America, organizing science clubs on a national basis, has been of additional great help to the junior academies through its "Cooperators" arrangement. By furnishing a central of-

fice through which exchanges of information and materials can be made, Science Clubs of America has been extremely helpful. Cooperators with this organization are kept in touch with the activities of the other junior academies by the preparation of digests of their communications and publications. Sets of the literature, publicity releases, "Things-of-Science" Kits, *Science News Letter*, and *Chemistry* are all sent to cooperators. Virginia and Tennessee have participated in state-wide Science Talent Searches coordinated with the Westinghouse Science Talent Search administered by Science Service and Science Clubs of America. As nearly as can be ascertained, all the active Junior Academies of Science have representatives appointed by the state academy to act as cooperators with this national organization.

Information on the early years of most of the junior academies is difficult to obtain. Records of few have been published. From such materials as were available the number of science clubs joining the junior academy in its first year of existence has been ascertained to be as follows: Indiana 8, Kansas 6, Iowa 13, Pennsylvania 14, Alabama 17, West Virginia 16, Oklahoma 16, Minnesota 7, and Wisconsin 15. Figures for the first year of operation of the other junior academies were unobtainable.

The boys and girls in the science clubs join the junior academies as club members rather than as individuals; that is, the clubs to which they belong join as a chapter of the junior academy, and all club members automatically become junior academy members. The most recent membership figures available, those for the 1945–46 school year, are shown in Table 1.

It is obvious, of course, that not all science clubs within a given state have become chapters of the junior academies. For example, in Wisconsin a careful survey of the high schools showed sixty-nine clubs to be active, when twenty-nine chapters were in the junior academy. The reasons for the incomplete membership vary from state to state; perhaps the newness of the movement in Wisconsin is one of the most important reasons there. Virginia and Florida very probably have enrolled almost all the active science clubs of their respective states. In the high schools the turnover of teacher personnel is great, and, as the sponsoring of science-club work is largely a reflection of the personal interests of the teachers, this bulks large as a factor in the continuation of science clubs in any given school. The same factor is also operative in junior academy membership. Active, enthusiastic sponsors may keep the club in the junior academy year after year.

One problem which has not yet been satisfactorily solved by all the junior academies is the problem of getting in touch with the lone science enthusiast in a school which is too small to boast of a science club. Steps have been taken by some of the state junior academies to remedy this situation. Both Virginia and Tennessee have initiated state wide-Science

TABLE 1

MEMBERSHIP IN THE JUNIOR ACADEMIES, 1945–46

	Chapters or Clubs	Student Members
Illinois	46	1,400
Indiana	40	1,200
Kansas	25	500
Iowa	?	?
Kentucky	28	675
Pennsylvania	23	500
Alabama	8	125
West Virginia	35	300
Oklahoma	10	300
Texas	14	?
Missouri	30	500
Missouri, St. Louis	?	?
Minnesota	12	120
Florida	124	2,000
Virginia	115	3,000
Ohio	0 (inactive)	0
Tennessee	40	400
Wisconsin	29	1,100
North Carolina	2	50

Talent Searches which run concurrently with the Westinghouse Science Talent Search. Based on state-wide interest, and with the awarding of scholarships to institutions within the state, these talent searches will materially aid in ferreting out the capable boys and girls within these states. The wide publicity given by the state organizations as well as by the national organization make for a greater likelihood of reaching the attention of the youngsters. The additional scholarships available also make the students and the teachers feel the effort of entering the contests to be more worth while.

THE financial support of the junior academies is exceedingly diverse. In Virginia, Tennessee, Iowa, and Kansas no dues are charged for membership, and the entire cost of operation is defrayed by the senior academy. Illinois charges 10 cents per student member, Indiana charges $1.00 for admission of the club to the junior academy and $1.00 per year dues for each club. In Kentucky the charge is 15 cents per student; in Oklahoma, 10 cents per student, with a minimum of $1.50 for the club; in Minnesota, 25 cents per student, plus $1.00 per school. When operating, Ohio charges were $1.00 for the adult sponsor and club, plus 15 cents for each student member. Pennsylvania and Florida charge $1.00 annual fee per club; Missouri charges $1.50 per chapter; Texas, Alabama, Wisconsin, and North Carolina charge an annual fee of $2.00 per club; and St. Louis, Mo., charges $5.00 per year per club.

Although these dues and fees help to support the junior academies, the senior academies in almost all states, realizing the worthiness of these projects, help to subsidize the junior academy work. In making this survey special attention was paid to the support and operation of the junior academies. Practically every junior academy presents a different situation. Thanks to the candor with which the questionnaire was answered, the following summary of support may be presented.

In Illinois, where the cost of operation has averaged about $150.00, the support comes about one-third from the dues and two-thirds from the senior academy and the High School Principals' Association; some additional support is obtained from commercial sources. This last consists of books and equipment and cash prizes to be awarded at the annual meeting.

In Indiana no figure was given for the annual cost of operation, but the cost of stationery, postage, etc., is assumed by the office of the state sponsor, Dr. Howard H. Michaud, Purdue University. When *Science Aids Service*, a now defunct joint publication of the Illinois and Indiana Junior Academies was being issued, the Indiana Senior Academy contributed toward its cost.

In Kansas and Iowa the annual cost of operation was placed at $100.00, and the entire support was given by the senior academy. Kentucky presents a more complicated situation. The cost of operation runs to about $275.00, with the support coming one-half from dues, one-seventh from the senior academy, and the rest from the Kentucky Ornithological Society and special financial contributions from affiliated clubs and from friends.

In Pennsylvania the annual cost runs to about $20.00, half coming from dues and half contributed by the senior academy. Printing is done free by high-school students so that this cost does not appear in the budget. In Alabama $40.00 comes from dues and $20.00 from the senior academy. In West Virginia the junior academy was in the process of reorganization so that no figures were available on these items.

The Oklahoma budget runs to about $50.00, with about 95 percent coming

from the dues and occasional help from the senior academy and scientific apparatus firms. In Texas the budget of $25.00 to $35.00 and in Missouri the cost of $50.00 are met by grants from the senior society. The annual cost reported from Minnesota was $25.00 to $30.00, with most income coming from dues, augmented by a grant of $10.00 from the senior academy. In Ohio the situation reported was a cost varying from $15.00 to $50.00, with the support coming entirely from the junior academy dues. Tennessee reported a budget of $12.00, with the support entirely from the senior group. The cost has probably risen in this state since the beginning of their Science Talent Search.

Wisconsin presents a unique cooperative situation. The state academy sponsors the junior academy and pays for part of the operational expenses, printing and the cost of the annual dinner for the state-wide district meeting winners being the major items in the academy budget for junior academy support. The University of Wisconsin, as part of its program of greater service to the people throughout the state, makes available the time of one of its staff members. The Chairman of the Junior Academy Committee is released from teaching duties in the Department of Botany in order to devote this time to the junior academy work. Office expenses, postage, and travel have also been assumed by the university in supporting the junior academy. The total cost is thus greater than for the other junior academies, especially if the time of the state sponsor is taken into account. Apart from this, the cost has run to about $350.00 to $400.00 per year during the years of the founding of this junior academy. Additional support has been given by a friend of the academy and by the local chapter of Gamma Alpha for prizes at the annual meeting.

North Carolina reported a budget of about $150.00, with $50.00 being contributed by the senior academy, $2.00 coming from dues, and the balance contributed by the State Department of Public Instruction, State Forestry Association, the North Carolina Education Association, Bird Clubs, and the Carolina Biological Supply Company.

It should of course be realized that the budgetary figures do not show the entire cost of operation in most of the states. The desire to further the careers of the youthful scientists has led many people to contribute their time and efforts. It is this enthusiasm and interest which have not only kept the junior academy movement going but also expanding.

The meetings of the junior academies are more uniform than the finances or the government. All have at least one meeting a year with the senior academy. This contact with the sponsoring group is invaluable. The senior members are always much impressed by the enthusiasm and the excellent presentations made by the junior members, and the latter are delighted to meet the men of science of their state. Those states which have sectional as well as state-wide meetings are Pennsylvania, Oklahoma, Ohio, and Wisconsin. In this last state there are two district meetings, one in the central part of the state and one in the eastern. Eight demonstrations are chosen from these district meetings to be presented at the state-wide meeting with the senior academy. In Oklahoma there are spring and fall meetings, the latter with the senior academy.

The most important feature of junior academy meetings is the opportunity given the boys and girls to present the results of their own researches. To them the field of science is new and full of interesting material. The professional scientist might have expected that the opening of the atomic age would lead to a preponderance of papers and demonstrations on such

things as atomic power, radioactivity, and rocket propulsion. Examine the programs of any of the junior academy meetings last year—the healthy spread of interests is reassuring. The range of interests can be shown by the topics chosen by speakers on the program in Maine: The Scientific Alarm Clock, The Manometric Flame, Wheels—Humble and Highbrow, Comparative Study of the Digestive System, Fingerprinting, Widal Test, Purification of the Bangor Water Supply, Testing Milk for Butterfat Content, Solubility and Specific Gravity of Gases, A Diving Helmet, A Homemade Six-inch Telescope and the Stars It Will Bring Closer, The Tesla Coil, Effect of Various Light Rays on Plants, Reproduction in Plants, Evolution in the Brain of Vertebrates, The Frasch Process for Mining Sulphur, Glass Etching, The Preparation of Sulphuric Acid, The Slide Rule, "B" Battery Elimination, Seeing Eye, Development of the Chick, Homemade Record-Changer, Diorama on Conservation, Diorama on Shore Birds, Working Model of Panama Canal Locks, Arteries of the Head, Unusual Properties of Minerals, and Uranium Minerals.

The eight papers of the state-wide meeting of the Wisconsin Junior Academy may also be taken as a sample. The topics ranged from Back-yard Insect Collecting, through The Importance of Soil Analysis, Cold Light, Applications of Atomic Energy, Blood Will Tell, Astronomy Hobby, and Hydroponics to Lift and Drag Coefficients of Airfoil Sections.

The gamut of the sciences is covered by the youngsters, and the depth of understanding of their topics sometimes startles the older members who stop in to visit the young academy members at their meetings. Naturally, with all the *élan* of youth they have no hesitation in presenting demonstrations covering tremendous fields in fifteen minutes. But how much more lively and interesting a session with these young people is than many a more academic discussion that we have all attended!

Besides these student demonstrations and papers, exhibits of projects prepared by the members are universal at the junior academy congresses. A frequent addition to the program is a speech by some distinguished state scientist. Usually this is limited to an address of welcome or to a speech at a banquet, but North Carolina is an exception. There the projects of students are exhibited and the only talks given are those by professional scientists. Most of the junior academies add motion pictures on science to their programs, only Kansas, Ohio, Wisconsin, and North Carolina omitting this phase of the annual program. Some few add field trips to the program. Trips to visit the campus of the college at which the meeting was held, to museums, industrial plants, or other places of interest were mentioned by Illinois, Pennsylvania, Alabama, West Virginia, Oklahoma, Missouri, Minnesota, Florida, Virginia, Ohio, and Tennessee as being at least occasional features of their annual meetings.

Although the stimulus of attending the meetings is usually considered a sufficient incentive among the junior academies, cash prizes, certificates, pins, and other awards are given to participants in many of the states. Indiana, Missouri, Pennsylvania, and Tennessee deem the participation in the meeting enough of an incentive toward good work. These do offer membership in the A.A.A.S. as an award; more will be said of this later. In Illinois and Iowa certificates are given for excellent work. In Kansas pins, plaques, science books, ribbons, loving cups, and a $10.00 prize to the best club are all awarded. In Kentucky awards of $10.00 to two demonstrations and $5.00 to four demonstrations are given. Ad-

ditional awards include four magazine subscriptions, pins, and ribbons. Alabama awards four cash prizes of $5.00 and four certificates of excellence. In West Virginia awards of both cash and certificates are made, but the amount was not specified. In Oklahoma cash, certificates, plaques, and academy pins are all awarded. In Texas an award is made by an apparatus company, and a gold pin is presented. The Dwight Institute Human Genetics project in Minnesota awards a $25.00 prize and one or more $10.00 prizes for family history information. In Florida awards are made of $10.00 for the best club exhibit, $5.00 for the best student exhibit, and of books for essay winners. Virginia awards are especially generous. There is a $50.00 award to a club, the presentation of honorable mention certificates, and fifteen boys and girls win a trip to the state capital in the state Science Talent Search. In Ohio certificates and keys are presented. In Wisconsin a $25.00 war bond, a $7.00 prize, and an award by Gamma Alpha constituted the prizes offered in addition to honorary memberships at the 1946 meeting. The North Carolina awards are varied: for the best biological collections, awards of $20.00, $15.00, and $10.00 are made; for the best general exhibits, awards of $20.00, $10.00, and $5.00; for the best forestry essay, awards of $20.00, $10.00, and $5.00; and for an ornithological essay, $20.00 and two books on birds are awarded.

Much more important as incentives of permanent value are the awards of honorary membership. Possibly not all members of the American Association for the Advancement of Science are familiar with the fact that two honorary annual memberships in the A.A.A.S., one to a boy and one to a girl, are available per state junior academy. These memberships entitle the recipient to *Science News Letter* for a year as well as other privileges. Not all the junior academies have taken advantage of this award. Illinois, Indiana, Kansas, Kentucky, Pennsylvania, West Virginia, Oklahoma, Texas, Missouri, Minnesota, Virginia, Tennessee, Wisconsin, and North Carolina, a total of fourteen, have availed themselves of this opportunity. In Wisconsin the award is limited to students in their junior year. This is expected to make the award more effective in the high school instead of having the benefits accrue when the recipient has left. Only three states have offered honorary annual membership in the state academy to promising young high-school students: Pennsylvania; Virginia (four memberships); and Wisconsin (six memberships). It would certainly seem that more of the junior academies should take advantage of the A.A.A.S. memberships and that more of the state academies should offer memberships as an incentive.

Very few junior academies reported use of the radio as a vehicle for their scientific talent. In Illinois the state station, WILL, formerly carried a weekly junior academy program. Iowa reported that a weekly broadcast has been maintained for a year. Indiana, Pennsylvania, Missouri, and Wisconsin reported occasional broadcasts on junior academy work. There is much opportunity for expansion of this type of junior academy activity. Few of those queried reported that speakers for the club programs were available. Indiana, Iowa, and North Carolina reported that speakers were available for a nominal fee or for travel expenses. Free speakers were available in Kentucky, Oklahoma, and Wisconsin. As an encouragement to the young people this is one service which every state academy should make available. No club should have a program made up entirely of outside speakers; the burden of the club programs as well as its management should fall upon its members if it is to be really successful in its purpose.

But to be able to obtain an occasional speaker, just to know that the older academy members were interested in them, would give most clubs a considerable measure of encouragement.

A few junior academies can also offer other services to chapters. In Indiana two motion-picture reels on lenses and three exhibit kits on venom, neoprene, and plastics are available. Oklahoma offers a loan set of pamphlets on organization and operation of science clubs. In Texas clubs are given a subscription to *Texas Game and Fish*. Two project kits can be borrowed in Missouri. Motion pictures showing one of the meetings are available in Ohio. Wisconsin offers loan sets of lantern slides in biology, and North Carolina offers the loan of six sets of slides and a projector. More traveling exhibits could certainly be devised to circulate among the member clubs.

Another field of stimulation of endeavor now being explored by some of the junior academies is the possibility of some of the youths being invited to help professional scientists in "co-projects" and thus initiate them into really scientific work. The Virginia clubs have two such opportunities, a project on the distribution and economic importance of Virginia plants in cooperation with the Virginia Academy of Science Committee on Virginia Flora, and a second project on minerals in cooperation with the State Geologist. Other projects were noted as being planned for that state if a demand developed for them. The Pennsylvania Academy of Science sponsors a Wildflower Phenology project in which cooperation on a state-wide study of the blossoming and fruiting dates of flowers is obtained. The Minnesota Junior Academy of Science has available a remarkably fine list of sixty-two projects in which the junior members could make a contribution to science. This unusual list of suggestions was made with the help of many members of the state academy and is the kind of work which will help to develop the superior student of science. The list covers problems in the field of biology and conservation; no comparable series for the physical sciences has been seen. In Wisconsin the junior members may cooperate with a committee of the state academy on a study of the distribution of the native trees of the state. Another project is on the phenology of wild flowers, and a cooperative project with the U. S. Soil Conservation Service local area office is available.

For all the science clubs, whether a junior academy is operative in a state or not, there are a number of coprojects which Science Clubs of America sponsors with federal and national agencies. Thirteen co-projects were available during the past two years.

Most of the junior academies have reported some sort of mimeographed publication which serves as a medium for announcements and exchanges of ideas for club and individual programs and projects and which keeps the clubs informed of one another's activities. Such publications are irregular in issue, but usually several numbers appear during a year. In some states the responsibility for each issue is taken by a different club. Such is the case in Alabama, Texas, and Wisconsin. Articles on science subjects, poetry, news items, announcements of meetings, and other notes of interest to the member clubs appear in these bulletins. Formerly the Illinois and Indiana junior academies issued a printed publication, *Science Aids Service*, in which news of not only the clubs of these states but of other junior academies appeared. This publication appears to have been discontinued. The only junior academy now issuing a printed publication with science articles and other contributions by science-club members is the Kentucky Junior Academy of Science. They sponsor an

excellent eight-page bulletin issued five to six times a year. This paper is a model for the other junior academies. Most of the contributions are by student members, and the encouragement given by seeing their articles and names in print is no doubt invaluable. Another publication which should be mentioned in connection with junior academy work is *The Science Teacher*, published quarterly at 201 North School Street, Normal, Ill. A special section of this magazine is devoted to science clubs and junior academy activities, with many of the articles prepared by the superior science students. A very interesting publication is the *Yearbook of the Illinois Junior Academy of Science* issued during 1945. All the clubs were given the opportunity to contribute articles to this publication. The eighteen projects upon which they worked in various fields of science are described in some detail by the boys and girls. Many photographs and line drawings illustrate the bulletin and add to its attractiveness. This is another idea worth exploiting in the encouragement of the youths in other states.

BECAUSE the junior academies are so much the outgrowth and reflection of the personal interests of the sponsors, the government of each is highly individual. It is difficult to make any generalization as the management depends upon the history and development of each junior academy. The most effective of the junior academies are those in which an individual is responsible and is supported by an ardently interested committee. The inclusion of science-club teachers as members of that committee is most desirable. The different types of junior academy governments are briefly outlined below.

In Illinois the junior academy is supervised by a Junior Academy Representative. He nominates teacher helpers who are then elected by the state academy. These teachers include the chairman of exhibits and four area representatives. A different state sponsor may be selected each year.

The Indiana Academy of Science appoints an eight-member committee, with the chairman, Dr. H. H. Michaud, serving as the state sponsor of the junior academy. The immediate governing body, however, is a group of five outstanding club sponsors elected by the club sponsors at the annual meeting to serve for five years, with one being elected each year and not being eligible to succeed himself within one year.

In Kansas the president of the senior academy appoints a committee composed of a chairman with a three-year term and five other members representing different parts of the state. The chairman is also a member of the senior academy executive board.

In Iowa the High School Relations Committee sponsors the junior academy. Two high-school teachers called Senior and Junior Counsellors are recommended by the junior academy and elected by the Executive Committee of the Senior Academy. At the annual meeting, high-school students are elected as President, Vice-President, and Secretary-Treasurer. These officers, plus the secretary of the senior academy and the Chairman of the High School Relations Committee, comprise the Executive Committee of the Junior Academy.

The Kentucky Junior Academy is controlled by an Executive Board of the Junior Academy, which is made up of the four officers. An Executive Committee appointed by the senior academy is a standing committee.

The fifteen-member Committee on School Service of the senior academy controls the Pennsylvania Junior Academy, but there also appears to be a nine-member Advisory Committee of high-school teachers from different parts of the state which operates the junior academy.

In Alabama a Junior Academy Committee of Counsellors of three members is appointed by the senior academy Executive Committee to serve three years each. The chairmanship is rotated, and the comment was made that a permanent chairmanship is needed. West Virginia was in process of reorganizing its committee so that information beyond the fact that the senior academy appoints the committee was lacking.

In Oklahoma the junior academy is organized as an independent organization from the senior academy. The chairman is elected by vote at the annual meeting of the senior academy, however, and there is a High School Relations Committee of the senior academy. Actual management of the junior academy seems to depend upon a group of high-school teachers interested in the work.

In Texas the junior academy is governed by a committee consisting of the Secretary of the senior academy, a general chairman appointed by the Executive Council of the Senior Academy and seven high-school teachers engaged in school club work and representing various areas of the state.

In Missouri the Executive Committee of the senior academy appoints a chairman to be in charge of the junior academy activities. He in turn nominates a committee of eight which is approved by the Executive Committee.

In Minnesota the President of the junior academy is a science teacher elected by the junior academy Council; the Secretary-Treasurer is also an adult chosen in the same manner. The Vice-President is a high-school student elected at the annual meeting. The President is also a member of the Council of the senior academy. The junior Council is composed of these three officers, plus four student members elected by the junior academy, four adults elected by the junior academy for a term of two years, and the retiring President and Vice-President of the senior academy.

In Florida government is by a committee of three. The senior academy Executive Council appoints a Chairman, the juniors elect a second adult, and these two select a third committee member, who usually resides in the city where the next annual meeting is to be held and who chooses his own committee on arrangements.

In Virginia there is an Advisory Committee of four and a Science Club Committee of fourteen members. The chairman of the Science Club Committee is appointed by the President of the senior academy. In turn, the chairman appoints the other committee members, six adults and seven students. A Governing Council of the junior academy consists of the President, Vice-President, and Secretary of the junior academy elected by the delegates of the chapters, the Chairman of the Science Club Committee, and two other members of that committee. In addition, the sponsor of the host club for the next academy meeting also serves on the Governing Council.

In Ohio there is a governing council composed of five members representing different areas in the state and four advisors representing the senior academy. One council member is elected at the state meeting each year.

In Tennessee the Executive Committee of the senior academy appoints a chairman who in turn appoints six additional committee members.

Because the junior academy in Wisconsin is sponsored both by the senior academy and The University of Wisconsin, the situation as to government is a little more complex than in the other states. It has proved a workable arrangement. The university has released the Chairman of the Junior Academy Committee from his teaching duties in the Department of Botany in order that he may devote his

time to the junior academy affairs; so that, in a sense, both the university and the senior academy Executive Council appoint the chairman. A committee to advise the over-all activities of the junior academy is appointed jointly by the university and the senior academy. In addition to this general supervisory committee, there is a second committee composed of high-school teachers active in science-club work. These represent different areas of the state, are nominated by the Chairman of the Junior Academy Committee, and are appointed by the senior academy Executive Council. Except for the close cooperation between the university and the senior academy, the situation as far as government is concerned is quite similar to that in Indiana. The university in addition to contributing the time of one of its staff members also provides considerable financial and other support in Wisconsin.

In North Carolina there is a High School Relations Committee composed of a chairman and six other members representing colleges, high schools, and the State Department of Public Instruction.

No information has yet been obtained of the government of the two new junior academies, Georgia and Michigan.

The thread of similarity which seems to underlie all these different responses to local environments seems to be a small committee of working high-school teachers and a chairman appointed by the senior academy to be on the active group and also on the advisory committee of the senior academy, the second committee. Several of the sponsors who returned questionnaires voluntarily commented upon the desirability of at least a more or less permanent chairmanship to insure a definite and continued policy.

What is expected to accrue from these activities? Obviously the program is designed to appeal to the superior, not the mediocre, students and to guide them along the pathways of science. Perhaps the Junior Academy of Science movement is at least part of the answer to a letter written to the Office of Scientific Research and Development by the late President Roosevelt when he asked:

> Can an effective program be proposed for discovering and developing scientific talent in American youth so that the continuing future of scientific research in this country may be assured on a level comparable to what has been done during the war?
>
> New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness, and drive with which we waged this war we can create a fuller and more fruitful employment and a fuller and more fruitful life (*Science*, December 15, 1944).

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WHY TERMITES?[1]

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ANTHROPOCENTRIC philosophers once assumed that all the creatures of the earth were placed here by the Creator for man's good or, if annoying or pestiferous, were the product of the Devil. This medieval concept still crops up in casual conversations. My fifteen-year-old nephew once asked me, "What good are mosquitoes?" In my less sophisticated moments, I give some credence to the hypothesis that mosquitoes were invented by the Devil. However, I do not put termites in the same category. I think termites are good—good for the biologist to study. This conviction sometimes shocks my friends, who seem to think that all my time should be devoted to eradicating these pests. If someone seeks my advice on how to exterminate termites from his house, my usual remark is, "Well, in the first place, you know that I am in favor of the termites."

I am not going to discuss the harmful effects of termites. In addition to the great damage to buildings, I have even heard of a case in which two chess players had to rush through their game because one of the bishops became infested with termites. Severe as the havoc is, I shall concentrate your attention on the more fundamental scientific values to be derived from the study of these insects.

Insects are too far removed from man—taxonomically, I mean—to draw forth much affectionate response or paternal solicitude. At least in my own case such affection has been relegated to the subconscious. A psychoanalyst friend once told me that biological inquiry is sublimated sexual curiosity, and that insects in some way are psychic symbols of children, possibly because there are too many of the little pests. Be that as it may, this is not the time to elaborate upon the individual psychology of either my entomological colleagues or myself.

Speaking of psychiatry, I was once telling a friend about the reactions of various peoples over the earth to my termite-collecting activities. Farmers and ranchers in the United States were worried; West Indian negroes thought I was crazy; South American Indians giggled and whispered among themselves; the Arabs of North Africa doubted by sanity; and the Italians discussed incarceration. At this point in my story, my "friend" remarked, "Well, a million people can't be wrong."

Enough of the reactions of the layman! Zoologists, I am sure, are able to appreciate the pearls cast before them, so I shall discourse upon why termites are good for scientific investigation.

The individual researcher is likely to approach biological problems along several paths. He may apply a certain technique to a variety of phenomena; he may choose a single principle and explore its manifestations in a variety of organisms; or he may choose a single organism or a restricted taxonomic group and attempt to study various correlated principles through the application of a variety of techniques.

I doubt if any approach is broader, narrower, or more productive than another. All have led to important results in the hands of skilled scientists. Occasionally a single investigator will apply one technique to one phenomenon in one organism. Rarely, a single individual may be able to

[1] From the address of the retiring Vice-president (Chairman of Section F), American Association for the Advancement of Science, Boston, December 29, 1946.

approach several problems with more than one method. Both depth and breadth have their values. Both analysis and synthesis are important aspects of science.

Termites are an order of insects with close to 1,800 described species, and many more await discovery. Through the early inspiration of a number of teachers and friends[2] I have found myself interested in all aspects of termite life. From among the many important principles exhibited by termite biology, I have chosen to place particular emphasis upon a phenomenon that is especially well illustrated by such social insects, namely, the integration of a population. Population integration is the result of the operation of many complex factors—factors that also produce other effects in other organisms—so that any understanding of termite society enables us to better comprehend other aspects of life and vice versa.

The adaptive evolution of the sterile castes of the social insects seemed to Darwin to be fatal to his theory of natural selection until it occurred to him that selection must operate upon the "family" as a unit. He subsequently found that the social insects provided some of the best examples of the influence of natural selection, at the same time affording an almost perfect proof that adaptive evolution could occur in the absence of any Lamarckian inheritance of acquired characters.

In the post-Darwinian decades, we may say that the accumulation of additional facts concerning the social insects has verified some of the essential aspects of the theory of natural selection of population groups and has assisted in the removal of some fallacious theories from modern biology.

[2] These include K. P. Schmidt, J. H. Comstock, Anna B. Comstock, William Beebe, J. G. Needham, O. A. Johannsen, J. C. Bradley, N. Banks, T. E. Snyder, W. M. Wheeler, F. E. Lutz, J. Bequaert, H. Lang, H. D. Fish, F. Silvestri, N. Holmgren, Y. Sjöstedt, N. A. Kemner, and S. F. Light.

A list of more modern generalizations may serve to focus our thoughts and give a base for discussion. Some of the following conclusions are considered invalid by leading contemporary biologists. By means of scientific controversy new facts and problems are discovered, new tests are applied, new lines of orderability become apparent, new applications are attempted, and both fundamental and applied science advances. Theodore Roosevelt once said, "Each scientist views the work of his colleagues with quarrelsome interest." I expect that this creative aspect of controversy will continue and that each fact and postulate will be critically scrutinized.

From the study of termites, a few generalizations may be made:

1. Population systems must be added to the several basic biological entities.
2. Population systems may be divided into two fundamental types, the species population with genetic continuity and the interspecies community with ecological continuity.
3. Populations have organismic attributes and may be appropriately called supraorganisms.
4. The more inclusive units incorporate the lower units together with their immediate environments, both physical and biotic. By this means, there is an organic evolution of the physical as well as the biotic environment.
5. The common characteristics of organisms and population systems are the result of natural selection of each unit through its internal and external relations.
6. Increasing stabilization and controlled periodicity of the internal and external environment (homeostasis) is a trend in the ontogeny and phylogeny of organisms and supraorganisms.
7. Significant parallels between insect and human societies have a common causation.

In order to clearly substantiate these statements, I should like to offer a clean-cut fact logically associated with each point. However, each series of related facts verifies several conclusions, so I am not attempting to adhere to the stated order of my conclusions in assembling the factual basis for these contentions.

In the first place, let us consider a most remarkable series of African termite nests described by Desneux, Stumper, and Sjöstedt. In my opinion, the nests I am about to describe afford the best example of the evolution of behavior yet discovered by biologists. Each of the nests is built by worker termites belonging to a colony of a species of the genus *Apicotermes*. Each is about the size of a basketball and is built in an excavated and lined subterranean chamber. Every nest possesses numerous tiny ventilation pores running through the wall. Three types of nests are known, constructed by five species of *Apicotermes*, and these may be arranged in what appears to be an evolutionary sequence. In the simplest type rows of uniformly spaced pimple-like projections occur on the outside surface. An arched pore extends from each projection through the nest wall into an interior chamber inhabited by the termites. The wall is probably formed from the claylike excrement of the termites, and the pores are molded as the wall is constructed by the cooperative activities of hundreds of workers.

The uniform repetition of these pores in the nest wall may be compared with the replication of structures in an organism. The best parallel is that of the pores in the wall of a sponge of the ascon type. Both the individual sponge and the termite nest are radially symmetrical with a geometric repetition of structures. One is a multicellular organism, whereas the other is the product of the behavior of a population of organisms. Obviously, the comparable similarity is pure analogy. From the functional viewpoint, however, both the organismic and social levels have evolved toward a more optimal internal balance of otherwise more variable environmental factors. This internal physicochemical constancy is called homeostasis by the physiologists (Cannon), and the same term applies to the relative constancy of the environment within the nest attained through social cooperation.

A second type of *Apicotermes* nest constructed by the workers of a different species possesses a series of enlarged openings on the outside of the wall, each leading into a tubular chamber before narrowing into the small pore homologous with the more primitive simple pore of the first type of nest.

A third type of *Apicotermes* nest, characteristic, with certain minor variations, of three different species, has circular galleries inside the walls that would seem to be modifications of the tubular chambers of the second type. Small outside holes lead into these circular galleries, and alternately arranged pores run from the circular galleries into the interior termite-inhabited chambers.

I am not sure that a word description of this series of termite nests can convey the precision of the geometric pattern, the modifications of homologous structures, and the obvious adaptive function of the architectural behavior of the termite workers. The evidence is clear, however, that we may apply certain concepts to the social behavior of an insect population that have heretofore been almost exclusively applied to the ontogeny and phylogeny of individual organisms. Such concepts as homology, polyisomerism, symmetry, and adaptive evolution, together with comparable basic physiologic and genetic induction mechanisms, may be exactly studied by the comparative social psychologists as well as by the comparative anatomist. The correlation between the psychic and the morphologic makes a dualistic philosophy increasingly untenable to biologists.

Nests constructed by other termites indicate that social behavior may exhibit regeneration, convergent evolution, and regressive evolution. Unrelated termites belonging to separate subfamilies construct similar chevron-shaped, rain-deflect-

ing ridges on the tree trunk above the nest. The similarity of the architecture is surely the result of convergent evolution in these instances, and the behavior is analogous. Hingston removed the rain-deflecting ridges from one nest of this type and witnessed the regeneration of the architectural pattern. Regression of the nest-building instinct is illustrated by a species belonging to a typically nest-building genus. In this particular species, which always lives on the stored food in a nest constructed by a very different termite, the ancient nest-building behavior has degenerated.

With such parallels between organisms and insect societies, if such terms as "supra-organism" or "epiorganism" (Gerard) are not used for the termite colony with its differentiated, sterile, "somatic" castes, then a new term must be invented to express the striking analogues common to the individual organism and the insect society.

Division of labor and structural orderability indicates antecedent operational physiological factors. What integrative mechanisms have been discovered that coordinate the insect society? Particularly through the recent work of Light and his associates, it is well established that the presence of mature males, females, or soldiers, respectively, inhibits the development of the same caste from undifferentiated nymphs. The best theory to account for the experimental results is that each of these castes gives off an exudate or "exohormone" that is passed through the colony by trophyllactic contact, thus inhibiting the development of either reproductives or soldiers unless the population increases beyond the minimum threshold amount of the inhibiting "exohormone." Theoretically, the worker does not inhibit the development of workers, but inhibition by reproductives and soldiers results in the development of workers in colonies of the higher termites in which this caste is present. Thus periodicities in the production of mature reproductive individuals in the colony of social insects has certain similarities to the hormonal mechanism periodically controlling the production of mature reproductive cells in the vertebrate organism. We have barely begun the study of social endocrinology, but we have some indication that the analysis of the social system may progress by applying methods similar to those that have proved effective in the analysis of the organism and its sexual adjustments.

Although the social insects are not suited to the experiments of classical genetics, they do indicate the existence of certain fundamental genetic mechanisms. For instance, it has been assumed by some that regressive evolution is the result of losses of the genes initiating the development of the character undergoing phylogenetic degeneration. Among the different genera of termites phylogenetic regression of the eyes of the sterile soldier caste is clearly indicated. Primitive soldier termites may have fairly large functional, pigmented, compound eyes, while an evolutionary reduction of pigment and of number and organization of the ommatidia is evident, ending in the total absence of the eye of the soldier in the most advanced termites. In this sequence of soldiers with reduced eyes, we have complete proof that the entire gene pattern for the development of functional eyes is present. The winged parents of each soldier possess functional compound eyes, and there is no genetic difference between the reproductive and soldier castes.

Modern physiological geneticists can cite organismic parallels to such a societal sequence. Sewall Wright has postulated that the abdominal appendages of an arthropod may undergo regressive evolution while the thoracic legs are progressively evolving, and yet there is no gene difference between the cells of the thorax and those of the abdomen of the same individual. The gene pattern influencing the development

of an organ under certain physiological conditions may have strikingly different effects under other physiological conditions. The basic gene pattern, once selected through the efficient functioning of an organ, may be intact even though no trace of the organ can be detected. The physiological conditions are themselves dependent upon hereditary factors in large measure and are undergoing adaptive evolution. The point that is illustrated by the phylogenetic regression of the eyes of termite soldiers is that the social insect population shows a striking parallelism to the individual organism and that an analysis of the biological mechanisms of one system is a step toward an understanding of the other.

Although it is not possible in so short a discussion to describe the series of integrated populations leading up from the species of asexual organisms to the highly social groups, it is increasingly clear from the experiments of Allee, Tinbergen, and their associates that numerous physiological and behavior mechanisms give rise to various levels of group coordination and that the social insects merely offer an extreme example of a population system. Such experimental work as that of Thomas Park on grain beetles gives us further precise information concerning population interactions. The species with its population parts is a true biological category taking rank in importance with the concepts of the cell and of the organism. As Allee and others have emphasized, cooperative interaction between the parts at all levels of integration is a fundamental characteristic of life.

There has been much opposition to the recognition of the reality of intraspecies population systems by biologists whose vision stops at the cell membrane or the skin of the organism. Even more opposition is to be expected if the concept of the supraorganism is applied to the interspecies biocoenose or ecological community. And yet much evidence accumulating shows that such properties of the organism as division of labor, physiologic and behavior integration, symmetry, dynamic equilibrium, homeostasis, ontogeny, and phylogeny are likewise characteristic of interspecies populations.

I shall cite only a single example to substantiate this point. Especially through the work of Cleveland, Hungate, and others, the interdependence of intestinal protozoans with certain wood-eating roaches and termites has been established. These flagellate protozoans transform the cellulose by means of enzymes, and the host insects are then able to absorb the resulting nutritive products. In the case of the roach the hind-gut is particularly highly adapted to the flagellate population. Chitinous valves prevent the flagellates from passing into the mid-gut with the nutritive fluids or from passing out of the body with the feces. The adaptive adjustments to the protozoa are quite comparable to the endoadaptations between tissues and between organs in the body of an individual organism. In other words, the flagellates function much as a tissue of the host, are serviced by the body of the host, and in turn service the body. Here we have an extreme example of a mutualistic relation between widely different species that are adaptively integrated into a supraorganismic interdependent system. Through the work of Kirby, Cleveland, and others, we can trace the phylogeny of such supraorganisms from the roaches to the termites and among the termites through generic and family divergence. The reciprocal evolution of both protozoans and host insects is apparent. Cleveland has advanced the ingenious hypothesis that the family adjustment of adult and young roaches was selected because of the greater efficiency in transferring the protozoans from one individual to another. Once the family

became the unit of natural selection, further adaptation toward more complex social life gave rise to sterile castes and greater social division of labor. Thus the social specialization of termites was preceded by the earlier evolution of the roach-protozoan supraorganism.

With the evolution of such a mutualistic system one might expect that the relationship between interdependent organisms, once established, would not be lost. However, the most advanced taxonomic family of termites, constituting three-fourths of the known species, has lost the protozoans, digests the cellulose without their assistance, and seems to have undergone an almost explosive adaptive radiation subsequent to its divorce from protozoan symbiotes. The evolution of this termite-flagellate interspecies supraorganism together with its subsequent regressive evolution indicates that an interspecies system may give rise to a better-adapted intraspecies supraorganism. We may also guess that greater cooperation between the parts of an integrated system is more easily evolved in genetically continuous systems than in ecologically continuous systems.

A large number of ecologists have contributed detailed information concerning the fascinating interrelations between organisms composing the ecological community. Among them Shelford, Wheeler, and Orlando Park may be mentioned. Much remains to be learned about community coordination, but it is already becoming fairly clear that the interspecies system has many organismic attributes and that it represents a real biological system of great importance. As with the social supraorganism, the ontogenetic and phylogenetic processes have led toward greater integration, interdependence, and ecological homeostasis.

The analogue of a community boundary or skin may even be significant. If the species of a given community have evolved reciprocal adaptations, one would expect that it would be difficult for unadapted foreign species to invade a community to which they had not become adjusted. A high proportion of plants and animals introduced from foreign communities fail to pass through such a biotic barrier. The new physical environment may be quite well suited to the introduced organism, but the relations to the other organisms are likely to be incompatible without a long process of natural selection that guides them toward a reciprocal adjustment.

One case among termites may be used as an illustration of a community barrier. Prior to 1890 an oriental species, *Cryptotermes dudleyi*, was introduced into Panama. Much searching has failed to disclose its presence in the natural forest or savanna, but the species is common in the houses and man-made structures throughout Panama. This termite was found living in the furniture of one of the laboratory buildings on Barro Colorado Island in the Canal Zone, but it could not be found in the forest twenty feet away from the house.

Whether it be competition with closely related indigenous species or an inability to ward off various predators or parasites that prevents the invasion of the natural community, I am unable to say, but there is a rich field for ecological analysis involved in the solution of such a problem. The economic aspects of biotic barriers are tremendous. If the introduced African *Anopheles gambiense* carrying malignant malaria had been able to invade the natural forests of Brazil, the dramatic eradication of the species from human habitats would hardly have been possible. A similar biotic barrier enabled entomologists to wipe out the infestation of the Mediterranean fruit fly in Florida.

I venture the opinion that certain parallels between the insect society in its community relations and human society have been suggested by this discussion.

In making comparisons between termites and men are we leaving the realm of science? Are parallels purely chance resemblances with no common attributes or causes? Are we in danger of entering the sphere of mysticism and metaphysics when we use the term "social" to include both a termite colony and a human aggregation?

There is much controversy concerning these questions. Some stems from ignorance of recently discovered facts. Some is the result of the inability of certain analytical minds to conceive of the synthetic whole. Emphasis upon differences in comparative systems sometimes blinds one to the similarities. Much difference of opinion is the consequence of too much unsubstantiated theory, and better solutions must await the patient accumulation of more detailed information. Verbal metaphors may be misinterpreted. Biology has been used to rationalize political bias, as I suspect was the case when Churchill suggested the study of termites to Stalin.

Insect and human societies are different in certain fundamental aspects. The evidence is strong that the major societal integration of insects is based upon genetically induced physiological and behavior mechanisms. The evidence is equally strong that the major societal integration of man is founded upon individual experience and learned behavior. Man shares his hierarchy founded upon leadership and dominance with the vertebrates. Man transcends the highest vertebrates in his ability to communicate by means of symbols and to transmit the experiences of one generation to the next by use of these symbols, thus building up a social heredity distinct from his germinal heredity. Whereas the insect society is closely parallel to the multicellular organism in its hereditary mechanisms, human society has acquired a traditional culture not transmitted through the germ plasm but through objects, customs, institutions, and language. As a result of learned behavior and symbolization, great complexities of social interaction occur in human society not manifest in other societies. Educational institutions, religion, and political ideology are absent from subhuman societies. The similar social patterns of insect and human populations are preponderantly analogous and not homologous, although there is much functional resemblance. We still find a host of striking convergences in the two systems—division of labor, communication, cooperation, architecture, agriculture, and partially isolated units within the species that tend to repeat and maintain the social structure of other units.

Both termites and men control their own microclimates through cooperative construction; they both protect, shelter, and feed associated plants and animals; their food supply is stabilized through storage and cultivation. The two types of societies have evolved toward more intricate and more controlled homeostasis.

The evidence clearly points to the germinal evolution of the insect society through natural selection. It seems reasonable to believe that human cultural evolution is also the result of a selection of the more cooperative systems leading toward increased social coordination. But, in the case of human society, selection must act upon cultural units in addition to gene systems. Comparable correlated orderability between widely different phenomena indicates a common causation.

An understanding of well-founded principles of organic evolution enables us to guide the rapid evolution of our domestic plants and animals. It seems reasonable to suppose that an understanding of the principles of human social evolution will enable us to direct our own rapid social advance. I think I am correct in stating that a tremendous increase in fact finding, correlation, and synthesis is necessary before the fruits from applied social science

can compare with the harvest from the natural sciences. Biology is as fundamental to the social sciences as the physical sciences are foundational to the biological sciences. Already genetics, medicine, agriculture, ecology, geography, psychology, and anthropology are bringing aspects of biology and sociology together, but I am confident that we are on the threshold of a much greater mutualism between these sciences. In the face of our increased power for destruction, it would seem imperative that much more support be given to researches in both the natural sciences and the social sciences. At the present time there is a lack of balance between these two fields of knowledge that may be disastrous if not corrected.

There may be more of the subjective, emotional, and untestable in social science than in natural science, but we are all aware that the natural sciences have faced great difficulties in overcoming prejudice and defeatism—difficulties that now hinder social science investigation. Some social scientists have a glorified concept of the precision and predictability of the natural sciences. Those social scientists who believe biological laws enable us now to predict coming events with exactitude are probably not acquainted with the Harvard Law of Animal Behavior which states that under precisely controlled conditions animals do as they damn please. Many problems in both the natural and social sciences resist solution, and a complete understanding of complex phenomena cannot be anticipated, but even the slow progress already realized has fully repaid the effort. The pessimism often detected among social scientists is in part the result of comparing their techniques and theories with those of the exact sciences. A comparison with the advances in biology would probably allow greater optimism. The problems of human society are much closer to those being solved by the biologists than they are to those of astronomy or nuclear physics. Without expecting Utopia, one may confidently expect an intelligent solution of some of our major social problems following an energetic application of scientific methodology to an analysis of social systems.

Notice my prediction does not include an increase in happiness! Possibly the constructive channeling of human aggressions away from class, racial, and international warfare may produce greater happiness, but happiness has a large subjective component not greatly altered by the environment of the individual. With our goals expressed in more objective terms, the applications of scientific methodology to social, economic, political, and moral problems will surely lead to a more adequate understanding of the forces involved, a more adequate control of our physical, biotic, and social environment, and greater security—in other words, society will evolve toward greater social homeostasis and will thus repeat the evolutionary trends so clearly indicated in the evolution of plant and animal populations.

Lest the concept of the evolution of the population supraorganism be construed as an advocacy of totalitarianism, either of the fascist or communistic type, I should like to sound a note of warning. The human social group, whether an institution, a class, a race, a tribe, a nation, or the species as a whole, has probably evolved through the operation of factors similar to those guiding biological populations—namely, a certain moderate amount of variation, a certain degree of isolation, a selection pressure favoring beneficial changes in relation to both the environment and the organization of the system, and the transmission of the basic pattern together with the surviving variations to succeeding generations. Whether human social evolution leads toward autocracy, fascism, communism, or democracy may

well rest upon the interaction of these political systems with the prime social evolutionary forces that parallel those of organic evolution in general. Variation may be partially analogized with the creative arts and sciences; germinal heredity with tradition and culture; isolation and consolidation of gene patterns with the isolation and consolidation of cultural patterns; natural selection with social selection of more efficient interactions; and "artificial selection" may be analogized with intelligent selection and perpetuation of the beneficial social variations. As in the case of the social insects, the integrated, cooperative, human group may be selected as a unit, so that survival may well be in terms of the value of the variant to humanity as a whole rather than for the good for a few at the expense of the many. Sacrifice by some for the good of the species as a whole has convergently evolved in both biological and human systems at all levels of organismic integration. Many ethical principles may thus be seen to have a scientific foundation.

Biological elimination is often conceived as ruthless and absolute. Competition may be beneficial at an optimum and deleterious at a pessimum or maximum, as Allee has experimentally demonstrated. Even at the physiological level, we find gradations in the factors of survival. The destruction of a soldier termite while it is protecting the colony may well exert a selective pressure favoring soldier genes in the reproductive castes. With integration based upon learning, elimination or survival of an attitude or an idea may not be correlated at all with the elimination or survival of the individual involved. We have witnessed a gross misunderstanding of the operational factors of social evolution in totalitarian states that eliminate individuals with variant ideologies, thus attempting rather unsuccessfully to destroy the social variability upon which progressive evolution depends. As in the evolution of nonhuman populations, the benefit to the whole group is not independent of the benefit to the individuals composing the group. The fittest society, in all probability, will not be either one in which the group exploits the individuals composing it or in which the individuals exploit the group. Rather it may be expected that surviving populations will be coordinated under such a formula as "one for all and all for one." And in the case of humans, we may expect an intradependent world society to emerge.

I hope I have conveyed some small inkling of the fascination that termites exert on the biologist and potentially on the sociologist. A comparative study of termite social organization gives us an insight into biological and social mechanisms, and principles of far-reaching significance are the outcome. It is my conviction that each taxonomic or ecological group of plants or animals, including humans, will well repay a close study of its organismic and ecological relations, both contemporary and ancient. An enormous number of correlated facts are necessary to build sound generalizations, and each tentative hypothesis should be verified by the further accumulation of pertinent information, whether the field of inquiry be natural or social science.

None of the reasons I have given for the study of termites occurred to me until long after I found myself engaged in detailed study of their life. Inductive science demands years of routine investigation by many individuals. In order to understand why anyone dedicates his life to such specialized research, I suspect we should have to consult the psychiatrist mentioned earlier. I also suspect that such abnormal aberrations have survival value. As Wheeler once put it, mutations in ancient apes produced a type of insane behavior characterized by a drive toward progress. Having survival value, this insanity soon spread to most of the ape's descendants.

TO A CADAVER

By Arden Almquist

I take this scalpel reverently,
Hesitant to violate the one thing
That was yours alone to give.
I do not know you—not even your name—
But I know your race.
You belong to those who stand in Simon's line—
Black Simon, who bore the burden of the Cross
When Jesus fell beneath the load—
Who have, the centuries since,
Borne patiently their own crosses,
Searching for liberty and life and honor . . .
If I dissect as reverently with this blade
As Carver held the test tube in his hand,
I can do you and yours no wrong.

I also know your sex . . . You are of those
Who give the race what continuity it knows
In all its fitful change.
Yet I know not how many sons you may have borne
Or whether you have known motherhood at all.
I can but guess your age, the work you have done,
The pains and joys you've had in alternation.
These are secrets shut from me forever.
But there are other secrets, hidden now by your brown skin,
Which through you I hope to learn.

I do not know you.
I only know that I am in debt to you . . .
And this much more, perhaps—
That but for some unguided stroke of Fate,
Or, more mysterious still,
But for some uncomprehended purpose of our common God,
I might lie upon this table,
Strong-smelling, cold, and hard,
Forsaken and alone,
And you might hold this knife.

LIAISON WITH YOUTH

By HARLOW SHAPLEY

President, American Association for the Advancement of Science

"I HAD obtained my radio operator's license from the government," writes Irwin Cole in the essay which follows, "and was discussing the oscilloscope with a friend on the air" when the answer was found to a problem that had bothered for a year, and forthwith the "slight trace of ripple in the pattern" was removed. Some unnamed radio amateur, professionally associated with a technical laboratory, had made a liaison by "air" with a young explorer.

In the other essay selected from the Talent Search winners, David Shappirio, young expert on wasps, reports the reinforcement of his knowledge and enthusiasm by the professional entomologists.

I am impressed with the importance of helping to remove ripples from the pattern at the critical times when discouragement is throttling enthusiasm. Probably the greatest boon to the exceptionally talented young scientist is the free and easy contact with competent elders. It is too easy to impress one's teen-age associates. (And teachers too often are too tired.) Their genuine bafflement and adulation often lead the gifted schoolmate into superficiality and empty exhibitionism. The experienced elder, however, with no less admiration for youthful talent, can easily in a single interview teach the value of balance, modesty, judgment, and accuracy. With proper handling even the fanatic can be rescued.

In our annual Science Talent Institute in Washington we try to provide for this liaison between those who would go far in science and those who have done it. We confront young talent with adult knowledge and experience. The forty winners of the Talent Search not only get to see the sights, scientific and otherwise, of the national capital and have the excitement of competition for the Westinghouse scholarships, but they meet on an intimate basis the top-ranking men of several fields. Personally and scientifically those conferences of experts constitute the most profitable phase of the Institute.

The continuing intellectual association of the isolated or semi-isolated scientist with those whom circumstance or choice has put in the thick of scientific activity, is an important problem throughout America at this time. The professional scientific societies do something to alleviate the intellectual loneliness of the amateur and of the heavy-scheduled teacher. But such occasional service is not enough.

Is there not perhaps an opportunity near at hand for deliberate and profitable liaison work on the part of the scientists who are in those large institutions where doctorates are earned and bestowed? Could there not be a systematic program of keeping in personal touch with every graduate? Many of them have gone out highly trained and fully ambitious. But they have too often become negligent of scientific responsibilities because of a heavy load of teaching and choring, or because of family diversions, or of unfriendly environment. A periodic check-up from the old school, or especially from a sympathetic former teacher and research guide, will often serve to keep willing sparks alive, and often serve to remove some ripples from the pattern.

OBSERVATIONS ON WASPS

By DAVID G. SHAPPIRIO

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DURING the past three years, I have collected wasps in the District of Columbia and surrounding area. A paramount reason for my interest in this field lies in the fact that, although the occurrence of wasps is quite widespread, little is known of their ecology. The group thus offers excellent opportunities for new and valuable observations.

My project is an investigation into the habits of these insects. This investigation will provide the basis for a complete list of the wasps occurring between the areas covered by the New Jersey and North Carolina lists, together with flight tables and notes on the habits of each species, as far as they are known. There has never, in recent times, been a list of wasps from this region, and such a list would undoubtedly have much value. It could be supplemented at a later date by similar investigations in other fields.

The following field observations comprise material not heretofore recorded.

Family Mutillidae. Female mutillids, because of their often dense pubescence and lack of wings, are known as velvet ants. They possess a long sting capable of inflicting a very painful wound on the collector who attempts to acquire them by hand. The male mutillid has no sting but possesses wings.

This family offers much opportunity for observation. Larval hosts of only seven of the thirty-one local species are known, and so little is known about specific characteristics that males and females often must be treated as distinct species. I have occupied much time in observations upon these very interesting insects.

On a June afternoon I was pulling up moss in a search for beetles when I noticed several mutillid females under the moss. They seemed unaccustomed to the bright light, and four specimens were taken. These were identified by Dr. H. K. Townes, of the U. S. National Museum, as *Dasymutilla cariniceps* Fox. Once in 1945 I found another *cariniceps* under moss, but attempts to trace it to its prey failed. I believe that this species may prey on certain insects found under moss.

On August 14, 1946, I noticed what appeared to be a queer spider and, on closer investigation, I saw that it was a pair of mating mutillids. Immediately I picked up the pair, since it is very unusual to capture mutillids while they are mating. I recognized the male as *Pseudomethoca geryon* Fox, but the female appeared to be *P. simillima* Sm., a species of which the male was already thought to be known. *Geryon* had until this time never been associated with a female *Pseudomethoca*. Mr. Schuster, of the University of Minnesota, confirmed my identification. This observation has proved that *P. geryon* is the male of *P. simillima*, and the male which formerly was known as *simillima* becomes a separate species. I am advised that this observation will be described by Mr. Schuster in a paper he is preparing.

On August 28, 1946, another pair of mating mutillids was captured. These were *Pseudomethoca frigida* Sm., identified by Mr. Schuster. Several additional matings of *Pseudomethoca* were observed during August, all on the surface of the ground at the edge of woods.

We have caught thirty-one species of mutillids in the past three seasons here, including many specimens of the rare genera *Ephuta* and *Photomorphus*. Professor Fattig took only twenty-one specimens of these

mutillids in fourteen years of collecting mutillids in Georgia.

Family Psammocharidae. One of the more interesting families in the class Insecta, all genera, with the exception of *Ceropales*, are parasitic on spiders. Although these insects inhabit shady areas which afford excellent cover and are in addition reluctant to fly, they are, without doubt, the most difficult of the wasps both to observe and to capture. Little appears to have been published on the rarer subfamily Psammocharinae.

While collecting late in an afternoon, I noticed a small red-and-black psammocharid dragging a paralyzed wolf spider. I should have liked to observe her further, but she approached dense bushes, and, to avoid her loss, I captured her. She was identified as *Arachnophila divisa* Say, by Dr. K. V. Krombein, of the U. S. National Museum. Her prey was identified by Dr. H. H. Swift as *Lycosa sp.*

Family Vespidae. To this family belong the commonest of the wasps in this region, those of the genera *Polistes* and *Vespula*. These genera include the true social wasps. Much about their ecology has been recorded.

During September 1946 I attacked an underground nest of *Vespula squamosa* in order to obtain any parasites present. I sprayed DDT into the nest by way of an entrance from which *squamosa* workers issued and found that the wasps emerged from another entrance. When I sprayed DDT down that entrance also, wasps emerged from a third entrance, this one over a yard distant. Then I noticed a fourth entrance, paper-lined, out of which queens and males only rose. Further investigation revealed a total of five entrances, one of which was lined with paper of the type used by the wasps in covering their nest. The passage connecting this entrance was also lined with paper.

The outstanding fact remains that only queens and males used this entrance. No previous record of such an occurrence has been noted.

Family Sphecidae. To the family Sphecidae belong a great part, if not the majority, of the wasps. For the most part, they are beneficial, because they utilize a variety of harmful insects as larval food.

During July 1944 I was fortunate in capturing a new species of the genus *Larropsis*. I saw a small black wasp dive upon a cricket and sting the cricket until it offered no further resistance. The wasp then began dragging the cricket off toward the base of a tree. As she entered some tufts of thick grass, I captured her to avoid losing her, but the cricket, unfortunately, was dropped and lost.

Dr. Townes could not find any similar species in the U. S. National Museum collection and identified her tentatively as *Larropsis* n. sp. Dr. G. E. Bohart, of the University of California, confirmed this identification. Because of the fact that this was a new species, the wasp was donated to the U. S. National Museum collection. The wasp is now being described by Dr. G. E. Bohart at the University of California in connection with his studies on the Larrinae.

I returned many times to the area in which I captured this wasp, to try to obtain more specimens of it, but the plants which grew there had been removed, probably dispersing many of the insects which nested there.

Motes argentatus, ordinarily very common in this locality, was extremely so during 1944. In fact, it appeared in surprising numbers throughout October, usually the "end" of the season. On November 19, in Rock Creek Park, wasps were noticed flying in an area in which I often collect. Since the temperature could scarcely have been more than 55°F., the matter was pursued further.

The only wasps present were *Motes argen-*

tatus Pal. de B., but these were flying quite actively, despite the temperature. Several specimens were taken, all females. On November 26 I was surprised to capture two more females; and by this time, regular visits were made to the lot to see how long the *Motes* would remain. The following is a list showing the dates of capture of *Motes argentatus* throughout the winter 1944–45:

November 26, 1944.....	2 females
December 19, 1944.....	1 female
January 28, 1945.....	1 female in snow
February 11, 1945.....	3 females
February 25, 1945.....	3 females
March 10, 1945.....	1 female in snow

Thus, these insects, normally considered to appear in hot weather only, were captured quite consistently during the winter months. May this not necessitate a revision of our usual beliefs concerning the seasonal appearance of wasps, at least for this species?

During 1945, several wasps were caught which did not resemble anything I had previously seen. These proved to be *Bembecinus nanus* Hdl. Throughout the summer of 1945 this species was abundant, and during 1946 it was often observed nesting, so that the prey, which up to that time was apparently unknown, could quite easily be ascertained. Several females with their prey were taken, the prey in all cases being *Graphocephala versuta* Say, a common leaf hopper. (Kindly identified by Dr. P. W. Oman, of the U. S. National Museum.)

The method by which the female *Bembecinus* gets her prey and transports it to her burrow may be described as "typical" for many of the solitary wasps. The female wasp seizes her victim, overturns it, and paralyzes it by stinging it in the thorax. She grasps the prey under her body with her middle and hind pairs of legs and, carrying the leaf hopper in this way, flies to her burrow. She lands directly at her burrow and opens it with her front pair of legs, which have been left free.

I have not observed the method by which she deposits her egg on the paralyzed prey, but she returns daily with one or two freshly paralyzed leaf hoppers for the larva now living in her burrow, resembling in this habit many of the Bembecine wasps. A paper on this observation and the one immediately preceding it has been accepted for publication in the *Entomological News*.

IT WILL thus be apparent that the field of entomology in this region offers endless possibilities for research. The broad implications of such studies will be manifest from the following quotation from Rau's *Wasp Studies Afield:*

> The social and solitary wasps afford especially fine material with which to work out such problems as the correlation of habit to structure, the origin of socialization among insects, the development of intelligence from instinct, as Whitman would have it, or the independent origins of instinct and intelligence, the problem of psychic acquisitions as per Lamarck, the position of natural selection as a factor in preserving and accumulating favorable variations in behavior, ...

THE GRAPHING OF EQUATIONS BY ELECTRONICS

By IRWIN H. COLE

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THE idea of graphing mathematical equations on a cathode-ray oscilloscope occurred to me while studying second-year algebra. The assembly of the proper controls in a cabinet in conjunction with the oscilloscope made it possible to graph equations very quickly.

Before discussing the method of graphing algebraic equations, it would be helpful to relate my experiences in building the oscilloscope. When I became interested in electronics seven years ago, my main goal was to obtain a radio operator's license and have my own short-wave station. I began to study the fundamentals of electricity, supplementing textbook study with experimentation using old radio parts. As I learned the functions of the various parts, I became so enthusiastic that I began constructing many devices for testing and checking information. It was in this way that the necessity for a cathode-ray oscilloscope first became obvious.

My original oscilloscope was constructed from a basic circuit diagram from the *Radio Amateur's Handbook* and was essentially a device for lighting the cathode-ray tube and producing a spot on the screen. This diagram had omitted an intensity control which was vital to the operation of the unit, and, since the other circuit diagrams were too costly to build, I decided to design this and several other additions myself, using available "junk-box" parts.

I discovered that, by changing the voltages on the focusing electrodes, the operation of the electron microscope could be duplicated. Unfortunately, specimens could not be placed inside the tube, but a very clear shadow picture of the various elements inside the tube appeared on the screen, magnified several hundred diameters. The image even showed various flaws and irregularities of the metals used in the tube.

After building a linear sweep oscillator, it was necessary to design positioning controls for centering patterns on the screen. This seemed to be quite difficult, as each circuit would cover only one quadrant of the screen. After trying about seven different circuits, I finally evolved one that would cover the entire screen. I now had an instrument that would perform quite well for my purposes.

It was about two months before the need was felt to add any improvements to it. A vertical and a horizontal amplifier increased the sensitivity of the unit to about one volt per inch, making it so sensitive that it had to be rebuilt and enclosed in a steel case. Even then, no matter how well the transformers were shielded or the d-c supply voltage filtered, there was a slight trace of ripple in the pattern. It was not until another year had gone by that I learned how to eliminate this fault. I had obtained my radio operator's license from the government and was discussing the oscilloscope with a friend on the air. He told me that he worked at Dumont Laboratories and had had similar troubles with an oscilloscope he had built. He suggested that I obtain a length of two-inch iron pipe from a plumbing supply company and enclose the cathode-ray tube in it, thus shielding it completely from the magnetic effects of any a-c components. This was very effective in eliminating the ripple.

Now the application of the oscilloscope to the graphing of equations may be described. The X and Y axes correspond to the horizontal and vertical movements of the spot on the screen. By varying the

voltages applied to the horizontal and vertical plates, the spot can be made to trace the graph expressed by the equation. Linear and quadratic equations in two unknowns are the easiest to produce, although many others are possible.

Any equation may be expressed by a pair of parametric equations using a third unknown, which in this case is time (θ). In general, if $y = f(x)$, then $y = f'(\theta)$ and $x = f''(\theta)$. When voltage varying as one of the parametric equations is applied to the horizontal deflection plates, and another voltage varying as the second parametric equation is applied to the vertical deflection plates, the image on the screen represents the combined parametric equations, which is the original equation.

To produce the graphs of linear equations, two alternating voltages of the same frequency and of the correct phase relationship are applied to the horizontal and vertical deflection plates. The slope of the line determines the ratio of the two voltages and their phase relationship. If the slope is negative, they will be in phase; if the slope is positive, they will be 180° out of phase. The line may be shifted to the right or left, according to the constant of the equation, by the positioning controls.

The circle is the easiest of the graphs of quadratic equations to produce. It is produced by impressing equal voltages of the same frequency, but 90° out of phase, on the horizontal and vertical deflection plates. By changing either the horizontal or vertical voltage, an ellipse is formed. The ellipse may be rotated on the axes by varying the phase relationships of the two voltages. Its location with respect to the origin can be set with the positioning controls.

The general equation for the circle is $x^2 + y^2 = R^2$, which can be broken down to the two parametric equations $x = R \sin \theta$ and $y = \mathrm{R} \cos \theta$. When both parametric equations are functions of θ, as is the case with the circle, the frequencies of the voltages are equal. When one equation is a function of θ and the other equation is a function of 2θ, as is the case with the parabola, the frequency of one voltage is twice the frequency of the other voltage. In every case the magnitude of the voltage is determined by the constant R. Since the only difference between $\sin \theta$ and $\cos \theta$ is that one is 90° out of phase with the other, by having one of the applied voltages lag the other by 90°, all the mathematical conditions of the parametric equations have been complied with, and the resulting curve is a circle.

The chief value of this project has been not only to make me familiar with the construction and applications of the oscilloscope, but also to further my knowledge of the graphing of algebraic equations.

Book Reviews

THE NEW ASTRONOMY

The Earth and the Stars. C. G. Abbot. xii + 288 pp. Illus. $3.75. D. Van Nostrand. New York. 1946.

SOME sixty years ago Dr. S. P. Langley, afterwards Secretary of the Smithsonian Institution, wrote an exceedingly readable book entitled *The New Astronomy*. About forty years later Dr. C. G. Abbot, then Assistant Secretary of the Smithsonian Institution, published a similar popular work, and now after another twenty years Dr. Abbot, as retired Secretary of the Institution, has revised the work under review, which as before is "intended for those who wish to acquire by easy reading a general survey of the universe they dwell in." In the preface to his book in the 1880's Langley made a plea for greater emphasis on the New Astronomy, or astrophysics, stating that the Old Astronomy was receiving most of the benefits of governmental and private support. The situation by now is entirely reversed, and the Old Astronomy is doing the begging, as might be inferred from the general content of Abbot's current work.

Comparing this revised edition with the first one, we note at once the improvement in format and typography. Even where the wording is the same, the entire work has been reset. Also the order of the chapters has been changed; we might say that what is now the first part was formerly the second, and vice versa. Beginning with The Mighty Universe, the author carries out his purpose "to give the general reader first of all the awe-inspiring picture which, with present knowledge, the universe presents." Many details are suppressed or transferred to later chapters in order that nothing should blur the large view. The solar system and related topics are now discussed in the second part; atoms, spectra, and star conditions are taken up after the chapters on the stars. This method of proceeding from the outside inward, from the large to the small, may have its advantages but it results in sketchy treatment in places, and there are some curious omissions. For instance, the velocity-distance relation for extragalactic nebulae is illustrated by a plate without comment, and neither here nor elsewhere in the discussion of galaxies is the name of Hubble even mentioned.

Very properly, considerable space is devoted to the author's own field of the sun. Besides a popular account of his well-known studies of the possible correlation of solar variation with changes in the weather, we have the always fascinating account of his experiments on the direct utilization of solar energy. He has accomplished, perhaps, as much as anyone in this field, having carried on all the cooking operations of a small family for a season or so with his solar cooker on Mount Wilson. In solar engines, however, no really striking advance seems to have taken place in the past fifty years. The development of atomic power close at hand on the earth bids fair to outstrip the use of the same kind of power transmitted to us by radiation from the sun.

The numerical data in the text have usually but not always been brought up to date and, like the glossary of terms in the appendix, would often not withstand the critical scrutiny of a teacher and students in the classroom. The general student of astronomy is usually introduced on the first day to the conception of fundamental

circles on the celestial sphere, but here he would find the meridian defined as a plane, the equator as a circle, the ecliptic as a path, and the horizon as bounded by a plane.

On the whole the author has written a very interesting work for general readers, and many of these will turn to it again and again. The New Astronomy never gets old.

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CARE AND TRAINING OF EXECUTIVES

Executive Ability: Its Discovery and Development. Glen U. Cleeton and Charles W. Mason. 540 pp. $4.50. Antioch Press. Yellow Springs, Ohio. 1946.

CLEETON and Mason have re-examined the executive's place in industry and society to take account of new information and in the light of changes in governmental and industrial policies since the first edition of this book was published. Thirty percent of the references are of 1940 or later and 54 percent are of 1935 or later. Yet the basic philosophy remains unchanged, and the orienting introduction of the first edition is reprinted in the current one.

The executive is analyzed from several standpoints, but always he is viewed as an important, socially conscious member of a democracy in which he must show broad vision and mature understanding of the interrelated interests of capital, labor, and consumer in order that all three may share equitably in the wealth produced by industry. The hard-driving exploiter of labor and the consumer is not the executive for whom or about whom Cleeton and Mason have written.

"An executive," they write, "is a person who is responsible for the efforts of others, makes decisions on questions both as to policy and practice, and exercises authority in seeing that decisions are carried out." About 12 to 15 percent of the personnel in a typical company have some degree of executive responsibility.

The book is written for the several million who are executives, who aspire to be executives, who must select and promote executives, or who must train them to meet their responsibilities as executives. It describes executive functions briefly in an early chapter and in detail in half a dozen later chapters. A final chapter considers the executive's place and obligations in a democracy.

The characteristics, selection, and training of executives are examined.

> An executive is a well-rounded individual who does not deviate outstandingly from the average person of general intellectual superiority when measured by psychological tests; but who does deviate outstandingly by exceeding the averages shown by others on estimated qualities involving health, drive, judgment of fact, reaction to human qualities, and leadership.

A number of rating scales are included in the volume to aid in selecting potential executives, appraising the abilities of present executives, or judging one's own executive ability. Two chapters are devoted to developing executive ability, and one consists of hints for prospective executives.

The psychologist who is not an executive is likely to be disturbed by the oversimplification of some of the difficulties of measuring personality traits and predicting their roles in the successful discharge of executive functions. For example:

> By applying the questionnaire it is possible to determine the extent to which a person is emotionally well adjusted. Using a similar list of questions, Bernreuter standardized and validated scoring keys for four personality traits referred to as neurotic tendency, self-sufficiency, introversion-extroversion, and dominance-submission. Later Flanagan validated scoring keys for the Bernreuter inventory

for two additional traits, self-confidence and sociability.

Neither of these men would claim that six separate scores should be derived from the Bernreuter inventory. In spite of such oversimplifications, the volume should be of interest both for the information it contains and for the problems it discusses which need further analysis and study.

The executive who is not a psychologist will find in the volume both elementary discussions of psychological processes and suggestions for their practical employment. Study and application of the principles discussed in *Executive Ability* should make him a better executive.

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THIS SHRINKING WORLD

Communication Through the Ages. Alfred Still. 201 pp. Illus. $2.75. Murray Hill Books. New York and Toronto. 1946.

THIS reviewer admits—but refuses for that reason to disqualify himself—a prejudice in favor of a new book by Professor Still, because of his experience in transmitting power electrically, his texts on the machinery involved, and his twoscore years as capable head of the electrical engineering department in Purdue University. Thumbing the pages of the book before settling down to reading, the reviewer recognized many of the diagrams which usually illustrate the development of the electrical arts of communication; but enough were unfamiliar to assure him of new subject matter and interesting reading.

And the book proved to be interesting, clearly and gracefully expressed, with now and then a humorous touch but more frequently a mildly caustic interjection which showed that the author was himself not without the saving grace of some prejudices.

Why was it, then, that the first chapter left a foreboding that one was on the way to something with which he wouldn't agree—and might even deplore? The last chapter justified the fear. Under the title, Communication without Words, it deals, sympathetically to say the least, with the subject of telepathy. Although the author says, "No attempt will be made here to prove the existence of telepathy," he then refers the reader to "the modern literature treating of this subject," which includes, as might be expected, the books of Thomas Jay Hudson, Oliver Lodge, J. B. Rhine, Whateley Carrington, Rudolph Tischener, and F. W. H. Myers.

The fact that the author does not adduce proof does not mean that he has any doubts, because on the same page he says (italics mine): "Telepathy *is* a means of communication. . .The *sages* of Oriental countries *have practiced it* from time immemorial. . . . The word [telepathy] was suggested by F. W. H. Myers *in 1882 when experimental proof was first given.*"

The author quotes Hudson as referring to "*telepathy* as *a normal means of communication between animals.*" (But how can anyone know that?) To it he credits the successes of many animal trainers. The friendly dog you meet when out walking "has in some occult manner gotten in touch with that part of you which is primeval and eternal." Well, if that is what the author wants to believe, the "will-to-believe" must be credited with some potency. From my own experience, however, I wouldn't trust the telepathy of a dog if I had a pack on my back or was mounted on a bicycle or scooter. When a child accepts a stranger, one usually ascribes his readiness to do so to past experiences with other men of similar clothes and manners who have proved friendly and interesting. Of course the child doesn't have the keen

scent of a dog nor his reaction to such faint odors as a surge of adrenalin might liberate from a stranger who was fearful.

If, as is usually true, the message of a book is to be found in its first and last chapters, this review might just as well end here. To no purpose would be any of the critical comments, captious or well justified, which might be directed toward some of the statements in the intervening chapters. If, in your scheme of beliefs, you need telepathy and extrasensory perception, read the book and enjoy what is to the present reviewer a still unjustified conclusion. If you don't, tear out the first and last chapters and you will be left some interesting historical information. But don't expect adequacy of treatment of present-day radio or the methods of television. Perhaps the sufficient reason for that inadequacy is that these portions of the electrical arts of communication are so much more complex than the earlier inventions that they resist similar portrayal.

JOHN MILLS

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ODYSSEY

Charles Darwin and the Voyage of the Beagle. Lady Nora Barlow, Ed. 279 pp. Illus. $3.75. Philosophical Library. New York. 1946.

THIS collection of family letters and notebooks written by Darwin during the voyage of the *Beagle* contains a few letters which have been partly published in the various biographies, but most of them are published for the first time in this book. Letters are always an intimate window through which to view family life, and Darwin's are particularly so. They are also a fine mirror of the little details of life in the early days of Victoria's reign. As for the notebooks, they are a series of 24 small pocket books in which Darwin entered all sorts of impressions, most of which were later expanded in his diary, together with such miscellaneous memoranda as supplies to be obtained in the next port of call and experiments to be made to verify the questions that occurred to him. These notebooks have been edited by the omission of much of the routine geological matter and the duller spots, but they are nevertheless a fine introduction to the young Darwin informally putting down his random thoughts and observations.

J. W. HEDGPETH

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ART AND THE GOLDFINCH

The Symbolic Goldfinch: Its History and Significance in European Devotional Art. Herbert Friedmann. 254 pp. Illus. $7.50. Bollingen Series, VII. Pantheon Books. New York. 1946.

IT IS not given to many scholars to combine their vocational and avocational interest so felicitously as Dr. Friedmann has here done in this book on avian symbolism. Besides being, professionally, Curator of the Division of Birds in the United States National Museum, with all the proficiencies in zoology and museology that such a position entails, Dr. Friedmann is also, extracurricularly, a recognized authority on the history of art. In this volume he has made his science of ornithology the background of a study in the realm of esthetics. Essentially, however, it is a scientific study so far as method is concerned, and it is significant that two years ago the gist of this book was presented before, and well received by, so conservative a scientific body as the Washington Academy of Sciences.

Birds, as well as other classes of the animal kingdom, have served man for many centuries to represent his ulterior ideas. When his thought and expression promised to become too blunt and direct for his finer

sensibilities, what was more natural than for him to use some animal and its attributes to symbolize by a roundabout and often more beautiful way what he was trying to say? Sometimes, as in the case of the roc and the phoenix, he created fabulous birds to serve his imaginative ends. Frequently, with the passing of time, original symbolic meanings became obscured and submerged in the common heritage or lingered merely as traditional decorations. Now, after many centuries, virtually every bird and beast has become to us more than a bird or beast.

Dr. Friedmann has chosen to limit his exploration to the allegorical symbolism of one bird, the European goldfinch (*Carduelis carduelis*), as it appeared in European devotional art for half a millennium, from the mid-thirteenth to the mid-eighteenth centuries. He has diligently searched the literature and examined the paintings in many American and European art galleries and found nearly five hundred paintings in which the goldfinch figure occurs, the bird usually being held in the Christ child's hand. Italian paintings, representing all the main schools, yielded the greatest number, but the symbol was found also in Spanish, Flemish, French, Germanic, Austrian and even Russian religious art. Furthermore, it was soon discovered that the symbolism involved was polyvalent and extraordinarily complex and could not be reduced to simple interpretation. Although the original thought behind the use of the small bird motif in a painting was probably the desire to give to the Christ child represented some attributes of a child, this would not have been enough, says Dr. Friedmann, to perpetuate the innovation. We have the author's own brief summary of the multiplicity of meanings that he found the goldfinch to represent:

> In common with other small birds, it was the symbol of the Soul; in common with other small birds with reddish markings it was a symbol of the Passion, the Crucifixion, and of Redemption [and even of Death]. Peculiar to it, and in this respect wholly Italian, was a connotation of Fertility (pictures in which it was included were thought as apt to insure offspring to the donors), and by a long and complicated series of mystical identifications proposed by various medieval ecclesiastics it also came to be a substitute for a long-established disease augur, the oldest version of which was the ancient Greek legend of the "charadrius" that cured jaundice by looking at the patient and absorbing the illness. The ravages of the plague, especially during the fourteenth century, brought the themes of disease augury and fertility close together, as a hope for survival, and gave the symbol greatly increased popularity.

Searching out the ends and ramifications of these symbolic meanings and assembling the evidence furnished a nice research problem. It meant combing medieval poems and sermons and the writings of Franciscan and Dominican mystics and correlating the data with the natural-history data of the old bestiaries and the medieval moralized versions of the classic sources, such as Pliny, Plutarch, Aelian, and Aristotle. It meant investigating the history of the plague for possible mystic usages. And the thoroughness with which Dr. Friedmann pursued his task is indicated throughout the book: by the succinct and well-organized way he has presented his material, the adequate annotations, and the extensive bibliography. There is a classified list of the illustrations as well as a complete list of paintings (arranged by schools) that have been found containing the goldfinch symbol.

The first part of the book is devoted to a general treatment of the symbolism of the goldfinch and to an analysis of the goldfinch in non-Italian art; the last part deals with the goldfinch in Italian art, the majority (about 90 percent) of devotional pictures containing goldfinches being of Italian origin. The Italian material falls into six groups, treated in detail: the Florentine school (Ambrogio di Baldese, Agnolo and Taddeo Gaddi, Daddi, Gozzoli,

etc.); the Sienese school (Taddeo di Bartolo, Fungai, Barna, Sano di Pietro, Benvenuto di Giovanni, etc.); the Venetian school (Giambono, Crivelli, Bellini, Solario, etc.) the Umbrian school (Raphael, Nuzi, Fiorenzo di Lorenzo, etc.); the schools of Milan, Bologna, and Ferrara; and the minor schools of Italy. In conclusion there are chapters on the iconographic and stylistic treatment of the goldfinch and on Michelangelo's unique reversional treatment of the bird in his marble tondo relief "Madonna and Child with the Young St. John."

Although this is a book primarily for the historian and student of art, it represents an excursion into scholarly fields that many others will appreciate. Touching upon such a wide variety of human interests (medicine, mythology, birdlore, painting, religion), it becomes more than an esoteric exercise; it forms an interesting footnote to the far-flung history of man.

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THE ANATOMY OF ERROR

The Natural History of Nonsense. Bergen Evans. ix + 275 + x pp. $3.00. Alfred A. Knopf. New York. 1946.

THIS is debunking at its classic best, a brainful of information about misinformation, written with a grand sense of humor, sometimes sly, sometimes rich, and sometimes with a sarcasm that nips.

The author is not any too convincing about the presence or absence of Adam's navel, with which he starts his discourse, but he is positive that the earth does not have four corners, though even he probably could not have convinced Voliva of Zion City, who had sailed around the world and knew.

Many other topics are introduced: the Arctic, which, at least in part, is not the desolation most people believe, but a delightful place in which to live; fish, which are never dropped by rain; and carrier pigeons, which have to be trained to find their homes. Instinct is discussed: there is a chapter on "birds in their little nests," and several pages on pet dogs and wild wolves and the "spontaneous generation" of honeybees in the carcass of a bull.

Throughout the volume Evans treats fanciful beliefs and warped facts in a most entertaining manner and, by undermining untruths, gives a great deal of information on a variety of subjects, among them anatomy, physiology, and even sociology. He has done a great deal of research attempting to track down some foundation for legends which recur in various parts of the world—such as the rearing of human children by wolves. In this particular instance he can find no reputable authority for such an occurrence.

The footnotes constitute an interesting bibliography and are worth reading. In stating that the gorilla, contrary to general belief, has no hair on its chest, the author cites his authorities as follows: "See Robert M. Yerkes and Ada W. Yerkes: *The Great Apes*. . . . See Carl Akely: *In Brightest Africa*. . . . See a gorilla."

Also, your human form divine is not so divine after all; instead of on four legs, as was intended, you walk erect, and some of the inner parts therefore do not fit so well.

The author is a trifle doubtful about Noah and questions the accuracy of some of Ernest Thompson Seton's observations, but the book is a good one, well written, informative, and entertaining.

I wish everyone would read it, but some people will not; and I am sure that tomorrow or next week they will telephone me, asking: "To decide a bet, Do snakes sting with their tails?" Or, "Do snakes swallow their young?"

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TWO CASE REPORTS

New Aspects of John and William Hunter. Jane M. Oppenheimer. xvii + 188 pp. Illus. $6.00. Henry Schuman. 1946.

The Endeavour of Jean Fernel. Sir Charles Sherrington. x + 223 pp. Illus. $3.50. Cambridge Univ. Press and Macmillan. New York and London. 1946.

MISS OPPENHEIMER'S two delightful essays on John and William Hunter are examples of the pseudopsychoanalytic approach to historical personalities. The first essay concerns itself chiefly with Everard Home, the unfortunate brother-in-law of John Hunter who for reasons best known to himself burned Hunter's voluminous notes some thirty years after Hunter's death, apparently after using them for his own publications. The second essay is an evaluation of the personality of William Hunter as revealed by his contacts and friendships with some of his prominent contemporaries. Under Miss Oppenheimer's essentially light touch and sympathetic feminine conclusions, the main characters emerge as fallible but lovable human beings, a no mean accomplishment when dealing with the truculent Hunter brothers. Even Home is described as "not so much wicked as he was unwise;" the drama of the situation would make it suitable material for a successful play with the currently popular ingredients of complex interfamily relationships and explorations into the dark corners of the human mind. The book is an achievement in the art of typography and bookmaking by The Southworth-Anthoensen Press.

Sir Charles Sherrington's definitive work on Jean Fernel, the outstanding French physician of the sixteenth century, is an example of the more usual scholarly work in the history of medicine. It is replete with learned footnotes and references to original sources, reproductions of original title pages, and sixty pages of appendices. It presents a vivid, thoughtful picture of medical practice and of medical art during the Renaissance. In contrast with the eighteenth century, when the experimental method had permeated medicine sufficiently to enable the Hunters to add surgery and obstetrics to science, the chief accomplishment of the medical leaders of the sixteenth century was to throw off the dead hand of scholastic systems and dogma. Fernel eschewed many superstitions, added new observations, and recognized the deficiencies of his knowledge. In that way he helped to clear the path for the next great step in medicine, the coupling of observation with experiment.

The two books provided two entertaining and instructive evenings, not only because of context and the periods touched upon, but because they inevitably led to further musings on the history of man.

The importance of history cannot be overestimated because history is the case report on the human species, whose physical and psychological health is not encouragingly demonstrated by its two attempts to commit suicide within the past three decades. Improvement does not seem likely unless, as the first step, the motives and the actions of the species are evaluated through careful perusal of the record.

In the field of the political-social history of man, there is almost no outdated material. Plato's *Republic*, Aristotle's *Politics*, Machiavelli's *Prince* have as much applicability and direct interest today as a current *New York Times*. This cannot be said of medical history. There are but few pages of Fernel's writings that have any application to the world of today. The truth of the matter is, I presume, that this demonstrates the sad discrepancy between man's material accomplishments and his advances in the more essential political and social areas. Whereas medical thought of the sixteenth century is

as dead as a dodo, the fundamental problems of politics and of sociology are almost as unresolved today as they were in the days of the Grecian city-states.

The physician of the Renaissance confronted by an epidemic must have been as helpless as is the modern politician face to face with the implications of nuclear fission. The triumphs of modern medicine would have been impossible without the historical transition of medicine through two great phases. The first, as exemplified by Fernel, was the destruction and abrogation of false concepts, pat systems, and verbose theories signifying nothing. The second, a positive period, whose classic example is William Harvey and which includes the Hunters, was the use of the experimental method. Unfortunately, politics and sociology have yet to reach the age of Fernel.

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RECENT MEDICAL PROGRESS

New Worlds in Medicine. Harold Ward, Ed. 707 pp. $5.00. Robert M. McBride. New York. 1946.

THE anthology has become an acceptable channel for the dissemination of information and is, in a way, a reliable indicator of the growth of public interest in a given field. That an anthology of recent progress in medicine performs a valuable service and finds an eager public, goes without saying. Ward's volume acquits itself of its task better than the average because the editor spices it with social needling, although his needles are of a special design. The social implications of medicine are, however, so vital to the future welfare of the nation and mankind in general that it is high time those concerned with the conquest of disease should also devote some attention to the immediate application of medical progress to society at large.

The salient features of this anthology are the broad scope of the medical information included in it and the readability of the selections. After gaining an enlightening bird's-eye view from the editor's introduction, the reader is led directly into a survey of the role of medicine in wars, ancient and modern, an intimate analysis of the unique problems of aviation medicine, the uses made of blood or plasma on the battlefield and far behind the front lines, and the general procedures of medical attention in modern warfare. As was only to be expected, the complexities of modern military medicine have kept pace with the general growth in complexity of modern warmaking. The excerpts are from high authorities and thoroughly lucid in style and content.

A considerable portion of the book deals with summaries of what many readers might consider by now well-established aspects of medical lore, such as the services of pathology in diagnoses, the value of medical physics and chemotherapy, the nature of the virus and bacteria, the scourge of epidemics and the strategy employed in their conquest or control, the nature of immunity, a survey of hormones, and the disorders covered by the term cancer. These sections do contribute to completeness and contain besides much recently acquired information.

Less well known to the public will be the sections on old age. It is now widely known that the percentage of older people in our population is constantly on the increase, and this group therefore well deserves the attention it has recently been receiving. Nutrition also comes in for its due recognition; particularly refreshing is the essay by A. J. Carlson, which is a just challenge to much thoughtless and fashionable ballyhoo. Subsequent selections deal with mental diseases

and some basic problems and theories of modern psychiatry.

The concluding three essays deal with the social implications of medical progress, which means with the question: How is all the preceding information to be best put to use by and for mankind as a whole? To the editor this part should have been the most challenging since its problems are as yet unformulated and judgments should still be in the creative or ripening stages. By right the reader should be aided by them to formulate an intelligent point of view on socialized medicine and related topics. The best service the anthologist can render is to stir up thoughts along new lines, supply fuel, and perhaps also direction.

It may well be claimed that this part is the weakest of the entire volume. The reader is not left with sufficient illumination to see the problem in its entirety. The obstacles to socialized medicine in our society and the arguments, right or wrong, of the medical profession, are slurred over. All he is offered is David Riesman's excellent essay on the need of preventive medicine, which is granted by all and sundry; B. J. Stern's article on Medicine and Society, in which it is elaborately proved with the aid of poignant historical and contemporary evidence, that medicine affects social welfare; and, finally, H. E. Sigerist's enthusiastic summary of the presumably admirable state of medical practice and health security in Soviet Russia. Recognizing the fact that an anthology is in some ways an individual creation reflecting the editor's taste and personality, one may still offer the humble comment that the reader can get little enlightenment from these essays on the none-too-easy problem of socialized medicine in the United States here and now.

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DENTAL PHASES OF PUBLIC HEALTH

Dentistry, An Agency of Health Service. Malcolm Wallace Carr, Ed. xvii + 219 pp. $1.50. Commonwealth Fund. New York. 1946.

THIS book is one of a group of twelve being published as a result of the studies of the New York Academy of Medicine Committee on Medicine and the Changing Order. Its object is to relate dentistry to "national health in a changing order." The separate chapters are the work of individual contributors who are outstanding in their particular fields. The whole has been ably edited and arranged by Dr. Malcolm Wallace Carr.

A brief review of the organization of the dental profession in its Civil, Military, Veterans Administration, and Public Health Service aspects is followed by parts dealing with the history, the present educational situation, the various facets of practice, the status of research, and dental problems in the field of socioeconomics.

Here is presented in one small volume an over-all view of dentistry. It should be helpful alike to the layman interested in its health service aspects, to the physician interested in an allied field, and to the practicing dentist. The last, as much as any other individual of a group, needs such a survey in order that he may not lose sight of the forest because he happens to be surrounded by trees. No dentist can afford to omit this book from his required reading list.

The chapters on dental education, dentistry in rural areas, dentistry for Negroes, and socioeconomics contain much factual information and suggestions for the improvement of present unsatisfactory conditions.

One might wish that the various subjects could have had more nearly equal treatment; however, they do not all possess the

same amount of background material for discussion.

The relation of dental to medical education and the difficulties of complete dental health service for everyone are realistically presented.

There are frank admissions of dental shortcomings in education, in practice, in research, and in ability to date to solve socioeconomic problems. But the remarkable progress of a profession only a few years over a century in age, coupled with the ability to publicly acknowledge its own shortcomings, augers well for continued improvement in all its relationships.

PAUL C. KITCHIN

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FOR PUBLIC HEALTH WORKERS

Health Instruction Yearbook, 1946. Oliver E. Byrd. ix + 399 pp. Stanford Univ. Press. $3.00. 1946.

THIS member of the group of yearbooks is of special interest to health workers. With the wide multiplication of medical literature it is increasingly difficult, but equally necessary, for a busy individual to keep up with developments in many fields. Time is limited, and journals are many. The abstractor, then, is a valuable person, whether his work appears in the back of another journal or in a yearly collection like this. The reader owes a debt to the person who selects articles with judgment and summarizes them with skill.

Dr. Byrd, who is Associate Professor of Hygiene at Stanford University, has done his work well. A suggestion or two is ventured. It is arguable whether it is not the province of such a book to question the occasional statement that looks erroneous. That would seem a service that could well be given. Otherwise, original errors are simply hand[illegible] on. At times, too, the subject matter of this book includes clinical notes that seem to belong rather to the medical or surgical yearbooks. It would be helpful also if the editor covered some of the leading foreign journals, rather than depending on a correspondent in the A.M.A. The amount of space given to world health conditions is intelligent. The high lights at the beginning of each chapter are excellent summaries.

It is a good collection and will be helpful to the health worker who wishes to keep abreast of the times or is looking for recent material in some special field.

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Comments and Criticisms

EXTREMES

Dr. Compton's article, "Science and the Supernatural," in the December issue of The Scientific Monthly, is a beautiful and a brilliant piece of work. I should like to present my humble congratulations to him through you.

DANIEL LUZON MORRIS

Evansville, Ind.

Compton's mistitled article, "Science and the Supernatural," with its disgusting regression to evangelism, belongs in a Baptist Sunday-school paper. It is beneath the notice of the enlightened.

ROBERT C. GIVLER

Tufts College

The foregoing comments are the briefest of those received on "Science and the Supernatural" by Authur H. Compton. They are sufficient to show the extreme divergence of opinion elicited by articles on science and religion. No other comments on Dr. Compton's essay will be published.—ED.

INFORMATION, PLEASE

Although I have been a member of the Association for several years, I am still in a quandary as to how one can obtain more detailed advance information regarding meetings and conferences. As a member of several other scientific societies, I became accustomed to receive regularly the advance announcements of meetings which are being planned. In addition to these announcements many other societies send out bulletins or programs containing all titles of the papers to be presented, frequently accompanied by brief abstracts.

It is my strong belief that the Association has not been making adequate use of its publications for publishing in advance the programs of meetings and conferences. It might serve a very good purpose to have even abstracts of the papers published before or after the meetings. Schrödinger pointed out recently that "We have inherited from our forefathers the keen longing for unified, all-embracing knowledge. . . but it has become next to impossible for a single mind fully to command more than a small specialized portion. . ." It might well be that such abstracts of papers dealing with all the multifarious branches of science would help to establish contact between the various sections of the Association. In this manner the Association could successfully counteract the dangerous tendency of overspecialization in present-day science by a very desirable integrating influence.

JOSEPH M. LAMBERT

Easton, Pa.

Prior to the Boston meeting of 1946 *the A.A.A.S. anticipated the suggestions made by Dr. Lambert. All publications of the Association carried preliminary announcements, particularly* Science *and the* A.A.A.S. Bulletin. *In the November issue of the* Bulletin *it was stated that the* General Program *of the meeting would be ready for distribution about December 1. Although its completion was unavoidably delayed, it was delivered before the meeting to those who requested it. Thus, except for abstracts of papers to be presented, full information about the Boston meeting was made available in advance.*—ED.

THE GOLDEN RULE

Dr. T. V. Smith uses good logic in pointing out that the golden rule has, in reality, a highly self-centered, arbitrary implication. However, this implication can be avoided by rewording the rule as follows: "Suggest unto others as you would have others suggest unto you."

A heavy traffic of dissimilar points of view is both robust and democratic. To restrict the area of discussion as Jefferson chose to do, often retards the intellectual growth of the person who makes the denial. The person who is applying for clarification and the interested public are also losers as a result of such a negative attitude. I can see no benefit in excluding any problem, religious or otherwise, from a value-seeking discussion. Even though the questions are asked with malicious intent, the answers can be so devised as to guide the discussion back into civil and constructive channels. Christ himself, when confronted by the malicious questioning of wily lawyers, did not side-step the issue but instead countered with ingenious replies which are classics of adroit technique.

VICTOR HOLTAN

San Francisco

The Brownstone Tower

Not long ago I had lunch at the Cosmos Club with the Assistant Secretary of the Smithsonian Institution who, like myself, was once an entomologist engaged in research. We fell to talking about the good old days when we were young. Then every day was an adventure. We asked questions, devised means to get the answers, and sometimes succeeded in solving our problems. The days were never long enough to do the things we wanted to do. We got tremendous satisfaction from our small discoveries, for we felt that we were adding something permanent to the structure of our science. In short, we had the enthusiasm and idealism of youth and, for a while, the opportunity to express in personal research that longing to understand and conquer some of the secrets of nature. But the paralysis of paper work crept upon us until my friend became an administrator and I an editor. The truly great scientists are those who retain the enthusiasm of youth throughout their lives and have the capacity to add other activities to their personal research.

Nowadays much thought and effort are being devoted to the discovery of young people who have the talent and desire to become scientists. Talent can be detected by performance tests, but intensity and persistence of desire are difficult to evaluate. How can one tell whether a brilliant young scientist will or will not succumb to the lure of a higher administrative salary? He may move up into a job that needs to be done and that he can do well, but his research may bear little fruit thereafter.

These were some of the thoughts that occurred to me as I read the essays of the winners of the Sixth Annual Science Talent Search. Each writer, all under eighteen, described his or her personal scientific investigations. I decided to publish two of these essays in this issue, not only to demonstrate the productiveness of very young scientists, but to show older scientists how to write more effectively for the SM. These young people have not yet learned to write artificially in the conventional third person, passive voice. They bring their science to life and make of it a vital and thrilling personal adventure. No professional scientist, I think, can read these essays without a feeling of nostalgia for the days when unlimited time and unlimited problems seemed to lie ahead.

It is all to the good that the Science Clubs of America, sponsored by Science Service, and the Junior Academies of many states (see the article by J. W. Thomson, Jr., in this issue) are encouraging the early expression of scientific talent among high-school students. Their lives are being immediately enriched by their scientific pursuits, and they may later contribute much to the philosophical and material welfare of the world. The science teachers in many high schools must also receive much credit for making possible the splendid achievements of their best students. How this is being done in one high school is described by Dr. Paul F. Brandwein in the March SM.

Many of the high-school students who have participated in the Annual Science Talent Search are certainly worthy of membership in the A.A.A.S. and are capable of understanding the SM. Yet, as I pointed out in the February issue, not one reader of the SM in my sample of 1,000 was under twenty. Cannot we older scientists give these promising youngsters additional help and encouragement by making them SM members of the A.A.A.S.?

F. L. Campbell